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MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
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Volume XXIV October-December 1985

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	8		19	for	*Neoxenophylla*	read	*Neoxenophila*
	13		33	for	*Gymnoascella*	read	*Gymnascella*
	82		4	for	*Gymnascoideus*	read	*Gymnoascoideus*
	138		41	for	*stercorarius*	read	*stercoraria*
	190		28	for	*Narashimella*	read	*Narasimhella*
			28	*for*	1966	*read*	1965
			29	for	20:	read	**19:**
	208		5	for	20:	read	**19:**

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TAXONOMY OF THE ONYGENALES: ARTHRODERMATACEAE, GYMNOASCACEAE, MYXOTRICHACEAE AND ONYGENACEAE

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ABSTRACT

A new approach to the classification of species, formerly placed in either the Gymnoascaceae or Onygenaceae, is provided by correlating the following previously underutilized or unscrutinized characters: degradative capacity, ascospore sculpturing, and mode of conidium dehiscence. Peridial morphology, formerly used for defining families, is now used only at the genus level. Four families are defined within the revised order Onygenales: Arthrodermataceae, Gymnoascaceae, Myxotrichaceae and Onygenaceae.

Most genera with the ability to degrade keratin have puncta on the ascospore walls and produce rhexolytically dehiscing conidia. These genera are placed in a revised **Onygenaceae** which includes *Ajellomyces, Amauroascus, Aphanoascus, Apinisia, Ascocalvatia, Auxarthron, Keratinophyton, Kuehniella, Nannizziopsis (gen. nov.), Neogymnomyces, Neoxenophila, Onygena, Pectinotrichum, Renispora, Shanorella, Spiromastix, Uncinocarpus* and *Xynophila.* Most are saprophytic on keratin in dung and soil, and on keratinous structures such as horn and hoof but *Ajellomyces* includes serious human pathogens. Anamorphs are named in *Chrysosporium, Malbranchea* or *Sporendonema*, or are unnamed but also produce rhexolytically dehiscing conidia.

Keratinolytic genera with smooth ascospores are placed in the **Arthrodermataceae** which includes *Arthroderma, Ctenomyces* and *Nannizzia. Ctenomyces* is a saprophyte found on feathers and in soil enriched with keratin. The remaining two genera contain both saprophytic species found on dung and in soil

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enriched with keratin, and species that cause ringworm. Anamorphs of most species are characterized by rhexolytically dehiscing phragmoconidia in the form-genera *Microsporum* and *Trichophyton*.

Of the remaining nonkeratinolytic species, one group is markedly cellulolytic, has fusiform, hyaline ascospores, and rhexolytically dehiscing conidia on apparently undifferentiated hyphae (*Malbranchea*) or on dendritic structures (*Geomyces* and *Oidiodendron*). These fungi, in the genera *Byssoascus*, *Myxotrichum* and *Pseudogymnoascus*, constitute a new family, the **Myxotrichaceae**, which inhabits processed and unprocessed cellulosic materials. The remaining species are placed in the **Gymnoascaceae**, a heterogeneous assemblage of taxa either lacking a peridium, or having a mesh-like structure of more or less thick-walled cells. Ascospore walls are smooth or slightly irregular. Genera included are *Acitheca (gen. nov.)*, *Arachniotus*, *Gymnascella*, *Gymnascoideus*, and *Gymnoascus*. Rhexolytically dehiscing conidia are not regularly produced in many of these taxa and none has a named anamorph. They do not form a distinct ecological group, although many are largely coprophilous, being found on herbivore and carnivore dung. Some are soil-borne.

Reduced or mesh-like peridia found in all four families of the Onygenales may have evolved as an adaptation to a reliance on animals for dispersal and habitat formation.

The following new species are proposed: *Aphanoascus canadensis*, *Gymnascella calcarea* and *Amauroascus pseudoreticulatus*. Fourteen new combinations are proposed in the Onygenales: *Acitheca purpurea*, *Amauroascus volatilis-patellis*, *Gymnascella afilamentosa*, *G. confluens*, *G. dankaliensis*, *G. devroeyi*, *G. hyalinospora*, *G. littoralis*, *G. marginospora*, *G. nodulosa*, *G. punctata*, *Keratinophyton durum*, *Nannizziopsis vriesii* and *Uncinocarpus uncinatus*.

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INTRODUCTION

The majority of fungi grow on higher plants or their remains. The Gymnoascaceae and Onygenaceae are unusual in that most of them are associated with birds or mammals. They include the only true fungi that vigorously degrade keratin, as well as several of the most important human pathogenic fungi. Members of these families are also common in the dung of birds and other animals, especially carnivores, and in soil enriched with dung or keratinous debris. In addition to the keratinophils, some of the species traditionally included in the Gymnoascaceae are cellulolytic, while still others attack neither cellulose nor keratin.

Soil surveys for keratinolytic fungi, carried out at the University of Alberta Mold Herbarium and Culture Collection from 1956 through 1969, yielded many cultures of gymnoascaceous/onygenaceous fungi. From 1961 to 1975, G. F. Orr sent UAMH several hundred cultures from soil or dung for deposit or identification. Many other workers have sent smaller numbers of keratinophilic fungi for identification. The anamorphs of some of these collections have been carefully studied and monographed (Carmichael, 1962; Padhye and Carmichael, 1971a; Sigler and Carmichael, 1976; Van Oorschot, 1980). The teleomorphs have proved more difficult to organize. Despite descriptions of numerous taxa by Apinis (1964), Apinis and Clark (1964), Kuehn (1960), Kuehn and Orr (1959; 1963), Orr (1970; 1976; 1977a,b,c), Orr and Kuehn (1964), Orr, Kuehn and Plunkett (1963a,b,c), Orr, Roy and Ghosh (1977), and other workers, no one has surveyed specimens and cultures of the entire group to delimit clearly species, genera, and families.

There have been a number of taxonomic revisions of parts of the Gymnoascaceae based on the literature or the study of a few representatives (Apinis, 1964; Orr, Ghosh and Roy 1977; Samson, 1977; Von Arx, 1971; 1977). None of the revisions has been comprehensive and they disagree regarding important taxonomic characters and in the description and delimitation of taxa.

The Onygenaceae has received much less attention (Malloch and Cain, 1971a,b; Rammeloo, 1982) and in spite of numerous suggestions of relationship to the Gymnoascaceae (Fennell, 1973; Malloch, 1981; Matruchot and Dassonville, 1899), a detailed comparative study has never been undertaken.

The following treatment was organized to satisfy three main objectives with respect to taxa traditionally disposed in the Gymnoascaceae and Onygenaceae. These objectives were as follows: 1. to compile published information on all named taxa, 2. to examine and compare as many representatives as possible, from existing collections and from new isolations, and, 3. to delimit the species, genera and families, and provide descriptions, illustrations and pictorial tables to aid in identification.

Historical survey of the Gymnoascaceae and Onygenaceae

Taxonomic concepts in the Gymnoascaceae and Onygenaceae have developed independently. Apparent remoteness of the two groups is due to the strikingly different morphology of the types of each family (see *Gymnoascus reessii*, Fig. 32d and *Onygena equina*, Fig. 63a). Although *Onygena* predates *Gymnoascus* by 23 years, the historical aspects of the Gymnoascaceae are discussed first since it has become the largest and most studied of the two groups.

Gymnoascaceae: Since the description of *Gymnoascus* and the definition of the Gymnoascaceae by Baranetzky in 1872, the characteristics and consequent membership or scope of the family have been debated. Baranetzky's definition for the group (1872) was based on the absence of a complete peridium enclosing the asci. This simple criterion served to include in one group, *Endomyces*, *Saccharomyces*, *Taphrina* and *Gymnoascus*.

In 1880, Eidam reviewed Baranetzky's Gymnoascaceae and removed *Saccharomyces* and *Endomyces*, arguing that their characteristics supported a closer relationship to other fungal groups (phycomycetes!). To the remaining taxa (*Taphrina* and *Gymnoascus*), he added his new genus *Ctenomyces* and created two subfamilies based on trophic characters, "parasitic gymnoascaceae," which included those which formed in leaves and fruits (*Ascomyces*, *Taphrina* and *Exoascus*), and "saprophytic gymnoascaceae," including the coprophilous genera *Ascodesmis* and *Gymnoascus*. He noted that *Ascomyces*, *Ascodesmis*, *Exoascus* and *Taphrina* appeared to be closer to the discomycetes and *Gymnoascus* to the pyrenomycetes.

Brefeld (1891) denied family relationship among Eidam's Gymnoascaceae and placed *Gymnoascus* in his "Carpoasci," and *Ascomyces* and *Taphrina* in the "Exoasci." These two groups represented a major division of all the ascomycetes known at that time.

Schroeter (1893) redefined the family to include simple cleistothecial ascomycetes with a peridium of loosely differentiated hyphae surrounding the ascogenous tissue. He included *Amauroascus*, *Arachniotus*, *Ctenomyces*, *Gymnoascus* and *Myxotrichum*.

Massee (1895) supported a broader family concept based on the absence of peridial structure and reinstated *Ascodesmis*, *Ascomyces*, and *Taphrina* in the Gymnoascaceae. He gave the latter two genera subfamily status.

Matruchot and Dassonville (1899) followed Schroeter and Brefeld, in part, but maintained a broad definition for the family. They divided the Gymnoascaceae into three tribes, Endomycetees (*Endomyces*), Onygenees (*Onygena*), and Gymnoascees (*Ctenomyces*, *Gymnoascus*, *Microsporum*, *Trichophyton* and *Achorion*. These last three genera were included because asci were formed "under some circumstances").

Clements and Shear (1931) proposed the new order Gymnascales characterized by "the free ascus or ascus-group, without protective hyphae or these limited to a loose or dense mass." The order included the Endomycetaceae, Schizosaccharomycetaceae, Monascaceae, and Gymnoascaceae. The Gymnoascaceae included *Amauroascus*, *Arachniotus*, *Conidiascus*, *Ctenomyces*, *Diplostephanus*, *Eidamella*, *Gymnoascus*, *Hexagonella*, *Lilliputia*, *Myrillium*, *Myxotrichum*, *Penicilliopsis* and *Rollandina*.

More recent taxonomic treatments of the Gymnoascaceae are summarized in Table 1. Benjamin (1956), using Schroeter's (1893) family concept, characterized the Gymnoascaceae as follows:

> Ascocarps [ascomata] roundish, usually a cleistothecium consisting of a lax network of interwoven often anastomosed, thin or thick-walled hyphae surrounding the ascigerous tissue, or rarely the latter devoid of a special hyphal investment. Peridial hyphae, when present, smooth-walled or roughened, simple or giving rise to variously modified branches or appendages. Asci irregularly disposed, globoid to pyriform, 8-spored, wall evanescent. Ascospores one-celled, globose, oblate, ovoid, or lenticular, smooth or sculptured. Asexual reproduction by conidia or chlamydospores.

He included, *Amauroascus*, *Arachniotus*, *Arthroderma*, *Byssochlamys*, *Ctenomyces*, *Eidamella*, *Gymnoascus*, *Myxotrichum*, *Pseudogymnoascus*, and a new genus, *Shanorella*. He excluded a number of genera listed by Clements and Shear (1931) (*Carpenteles*, *Conidiascus*, *Diplostephanus*, *Hexagonella*, *Lilliputia*, *Myrillium*, *Penicilliopsis* and *Rollandina*).

Kuehn (1958; 1959) published a survey of the family which included his new genus *Pseudoarachniotus*. His definition of the family was similar to Benjamin's (1956). In neither treatment was any emphasis placed on the mode of conidiogenesis. The family, according to Benjamin and Kuehn, had anamorphs producing "oidia, chlamydospores, or conidia." Indeed, Benjamin stated, "What significance if any, is to be attached to the imperfect stages [anamorphs] encountered in the Gymnoascaceae is not apparent."

In 1964, Apinis revised the family but restricted his conservative treatment to species found in Britain. He

TABLE 1 SUPRAGENERIC GROUP NAMES USED FOR GYMNOASCACEOUS GENERA BETWEEN 1956 AND 1980

Benjamin 1956		Gymnoascaceae
Amauroascus *Byssochlamys* *Gymnoascus* *Shanorella*	*Arachniotus* *Ctenomyces* *Myxotrichum*	*Arthroderma* *Eidamella* *Pseudogymnoascus*
Kuehn 1958, 1959		Gymnoascaceae
Amauroascus *Byssochlamys* *Gymnoascus* *Pseudogymnoascus*	*Arachniotus* *Ctenomyces* *Myxotrichum* *Shanorella*	*Arthroderma* *Eidamella* *Pseudoarachniotus*
Apinis 1964		Gymnoascaceae
Arachnoideae	Arthrodermoideae	Gymnoascoideae
Amauroascus *Arachniotus*	*Arthroderma* *Ctenomyces* *Shanorella*	*Actinodendron* *Gymnoascus* *Myxotrichum*
Benny and Kimbrough 1980		Gymnoascaceae
Arachnoideae	Arthrodermoideae	Gymnoascoideae
Amauroascus *Arachniotus* *Arachnotheca* *Byssoascus* *Narasimhella* *Renispora*	*Ajellomyces* *Apinisia* *Arthroderma* *Nannizzia* *Shanorella* *Spiromastix*	*Auxarthron* *Ctenomyces* *Gymnoascus* *Myxotrichum* *Pectinotrichum* *Pseudogymnoascus*

excluded *Byssochlamys* due to the penicillate conidiophores with phialidic conidiogenesis. This was the first time in the Gymnoascaceae that any taxonomic significance had been placed on the mode of conidiogenesis. He organized the species among three subfamilies separated on characteristics of the peridial elements and appendages. The Gymnoascoideae included *Gymnoascus* (in which genus he included as subgenera *Auxarthron* and *Pseudogymnoascus*), *Myxotrichum* and *Actinodendron*. The Arthrodermoideae included *Arthroderma*, *Ctenomyces*, *Nannizzia* and *Shanorella*, and the Arachnoideae included *Amauroascus* and *Arachniotus*.

No attempt was made to correlate peridium features with other morphological characteristics such as ascospore shape and ornamentation, although variations in these characters were noted.

Benny and Kimbrough (1980) also treated the Gymnoascaceae in three subfamilies, separated on the basis of characteristics of peridial hyphae. Their system more or less coincided with Apinis' treatment. The Arachnoideae included *Amauroascus*, *Arachniotus*, *Arachnotheca*, *Byssoascus*, *Renispora* and *Narasimhella*. *Ajellomyces*, *Apinisia*, *Arthroderma*, *Nannizzia*, *Shanorella* and *Spiromastix* were placed in the Arthrodermoideae. *Auxarthron*, *Ctenomyces*, *Gymnoascus*, *Myxotrichum*, *Pectinotrichum* and *Pseudogymnoascus*, because of their highly differentiated peridial hyphae, were placed together in the Gymnoascoideae. As in the subfamily system of Apinis, no consideration of ascospore morphology was included.

Onygenaceae: The Onygenaceae, typified by *Onygena*, was proposed by Fries in 1849 to contain stipitate, cleistothecial ascomycetes. Fischer (1897) placed the Onygenaceae in the Gymnoascales close to the Gymnoascaceae. Clements and Shear (1931) placed the family in the Tuberales with the Elaphomycetaceae and Tuberaceae (truffles). They considered the Onygenaceae to include *Dendrosphaera*, *Onygena* and *Trichocoma*. Boedijn (1935) revised the family to include three monogeneric subfamilies: Dendrosphaeroideae (*Dendrosphaera*), Onygenoideae (*Onygena*), and Trichocomoideae (*Trichocoma*). These subfamilies were raised in rank to families within the new order Onygenales by Ciferri in 1957. Table 2 summarizes organization of onygenalean genera from 1957 (Fennell's (1973) treatment is excluded). Malloch and Cain (1971b) revised the family definition to exclude stipitate cleistothecial ascomycota that had phialidic or annellidic anamorphs and thereby removed *Dendrosphaera* and *Trichocoma*. Their description of the Onygenaceae (1971) follows.

> Mycelium hyaline, often with ampulliform swellings. Ascocarp initials consisting of large prominent coils or swollen cells. Ascocarps variously shaped, stipitate or sessile, hyaline or light colored, never dark brown or black, glabrous to hairy or tomentose or variously appendaged, nonostiolate, frequently varying greatly in size within the same collection. Asci subglobose to globose, irregularly disposed, nonstipitate, evanescent, usually arising from prominent croziers. Ascospores one-celled, hyaline to brightly colored, never dark brown to black, variously shaped, often oblate, smooth to roughened or ridged, with equatorial ridges in some genera, always lacking germ pores. Conidial stages produced as arthroconidia or aleurioconidia, never as phialospores or annellospores. Conidia hyaline, one- to several-celled, smooth or roughened. Frequently occurring on keratinous substrates, but also on dead plant debris and soil.

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TABLE 2 GENERA ASSOCIATED WITH THE SUPRAGENERIC NAMES RELATED TO THE GENUS *ONYGENA* FROM 1957

Ciferri 1957		Onygenales
Dendrosphaeraceae	Onygenaceae	Trichocomaceae
Dendrosphaera	*Onygena*	*Trichocoma*
Malloch and Cain 1971b		Onygenaceae
Aphanoascus	*Arachnomyces*	*Ascocalvatia*
Dichotomomyces	*Onygena*	*Thermoascus*
Xynophila		
Benny and Kimbrough 1980		Onygenales
Dendrosphaeraceae	Gymnoascaceae	Onygenaceae
Dendrosphaera	*Ajellomyces*	*Anixiopsis*
	Amauroascus	*Arachnomyces*
	Apinisia	*Ascocalvatia*
	Arachniotus	*Dichotomomyces*
	Arachnotheca	*Diehliomyces*
	Arthroderma	*Leucothecium*
	Auxarthron	*Keratinophyton*
	Byssoascus	*Neoxenophylla*
	Ctenomyces	*Onygena*
	Gymnoascus	*Pleuroascus*
	Myxotrichum	*Thermoascus*
	Nannizzia	*Xanthothecium*
	Narasimhella	*Xylogone*
	Pectinotrichum	*Xynophila*
	Pseudogymnoascus	
	Renispora	
	Shanorella	
	Spiromastix	
Currah		Onygenales
Arthrodermataceae	Gymnoascaceae	Myxotrichaceae
Arthroderma	*Acitheca*	*Byssoascus*
Ctenomyces	*Arachniotus*	*Myxotrichum*
Nannizzia	*Gymnascella*	*Pseudogymnoascus*
	Gymnoascoideus	
	Gymnoascus	
Onygenaceae		
Ajellomyces	*Keratinophyton*	*Pectinotrichum*
Amauroascus	*Kuehniella*	*Renispora*
Aphanoascus	*Nannizziopsis*	*Shanorella*
Apinisia	*Neogymnomyces*	*Spiromastix*
Ascocalvatia	*Neoxenophila*	*Uncinocarpus*
Auxarthron	*Onygena*	*Xynophila*

They included *Arachnomyces*, *Ascocalvatia*, *Aphanoascus* (in which they included *Keratinophyton*), *Dichotomomyces*, *Onygena*, and *Xynophila*. *Pleuroascus* was added in 1973 (Malloch and Benny, 1973).

Fennell's (1973) concept also considered the Onygenaceae as cleistocarpous Gymnoascaceae occurring frequently on keratinous substrates. She summarized their morphological characteristics as follows:

> ascocarp initials (unknown in *Onygena*) consisting of coiled ascogonia; ascomata usually spherical, stipitate or sessile, red brown to brown, peridium membranous, with or without appendages; asci arising from croziers. Conidial states arthroconidia and aleurioconidia.

With respect to the "unknown" initials, Gaumann (1929) reported that, at multiple sites within the "head" of the *Onygena* fruiting bodies, coils "superficially like *Penicillium* form and give rise to the ascospores." These coils were illustrated (Gaumann, 1928, FIG 118, 3, p187). Malloch (1981) also referred to multiple ascogonial initials in *Onygena*. *Xylogone*, which had been included in the Onygenaceae by von Arx and Nilsson (1969), was placed in the Monascaceae "arbitrarily" with a note that its taxonomic disposition might well be made elsewhere. Fennell (1973) differentiated the Monascaceae from the Gymnoascaceae on the basis of the peridium of flattened cells, and from the Eurotiaceae on the basis of arthroconidium production. She did not suggest a distinction between Onygenaceae and Monascaceae. She did not include *Thermoascus* and *Dichotomomyces* in the Onygenaceae but placed them in the Thermoascaceae (Apinis, 1967) and Eurotiaceae (Clements and Shear, 1931) respectively. Neither did she refer to *Ascocalvatia* nor *Xynophila*.

While studying a variety of reduced or yeast-like fungi, Redhead and Malloch (1977) referred their new genus *Galactomyces* (which included *Endomyces geotrichum* Butler and Petersen, (1972) and *Endomyces reessii* van der Walt (1959)) to an expanded concept of the Onygenaceae. They supported the disposition of *Galactomyces* in the Onygenaceae, using the evidence that *Geotrichum candidum* Link (arthroconidial state of *Endomyces geotrichum*) is associated with milk and other animal exudates, and produces "ascospores with an equatorial groove."

Malloch (1979), considering the resemblance of the anamorphs of members of Gymnoascaceae to those of the Onygenaceae, suggested that one family should encompass nearly all the genera included to date. He stated that the most characteristic feature of the new family concept was that conidia are never "enteroblastic" but "holoblastic" or "thallic." He suggested that there were about 30 genera but did not list them. *Myxotrichum* and taxa with "dark-colored" cleistothecia were tentatively, and with some reservation, assigned to the Pseudoeurotiaceae.

In a discussion of the putative families of the Pezizales, Malloch (1981b) described the Gymnoascaceae as differing from the Onygenaceae only in the nature of the peridium and again suggested that Onygenaceae could encompass the genera of both families.

Benny and Kimbrough (1980) again reviewed the genera of the Onygenaceae essentially reiterating Malloch's (1971) definition. In addition to *Onygena*, they included 13 genera (see Table 2). One of these genera, *Diehliomyces*, was a new addition to the family. Another, *Dichotomomyces*, is now regarded as having annellidic conidiogenous cells (Tubaki, 1981) and may therefore be removed.

New concept of the Onygenales

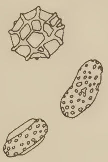
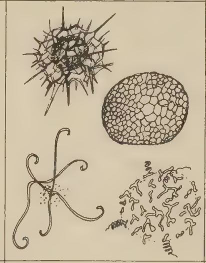
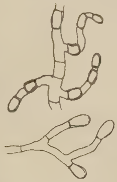
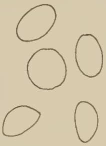
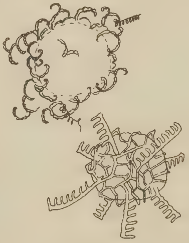
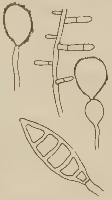
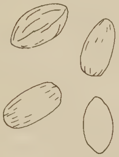
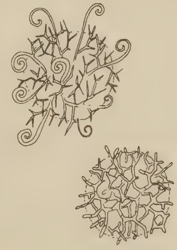
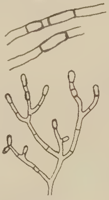
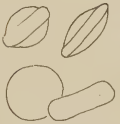
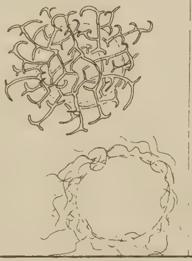
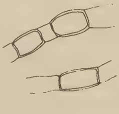
Previous family concepts placed primary emphasis on characters of the peridium. The final distinction between the two families was based on whether or not the peridium is complete, or mesh-like, or absent. This has obscured the importance of other characters such as ascospore morphology, nature and occurrence of anamorphs, and enzymatic capacities, all of which contain significant information for making a classification of the fungi traditionally treated in the two families. Various workers have suggested independently that the Onygenaceae and Gymnoascaceae might best be accommodated in one taxonomic unit (e.g. Von Arx, 1981). Alexopoulos and Mims (1980), Barr (1983), Benny and Kimbrough (1980), and Eriksson (1982a,b) have suggested that the Onygenales encompass both the Gymnoascaceae and Onygenaceae. A close relationship between the two families has been suggested since 1899 when Matruchot and Dassonville combined them within the Gymnoascaceae. Recently, one-family status for the group was again suggested by Malloch (1981b) who considered the Onygenaceae (including the Gymnoascaceae) in the Pezizales.

My observations agree with placing the two families in the order Onygenales but I also feel that the families and subfamilies, as they have been traditionally defined, are heterogeneous.

It is a common observation that keratinous materials are frequent collection sites for the group. Many representatives will degrade keratin supplied in culture (English, 1963a,b; Safranek and Goos, 1982). Some members cannot degrade keratin, but can degrade cellulose and/or other nonkeratinous compounds. The taxonomic significance of these contrasting enzymatic capabilities is obscured by the traditional genera, based on peridium characters, which contain both keratin-degrading and non keratin-degrading species, e.g. *Gymnoascus uncinatus* and *Gymnoascus reessii*, *Amauroascus niger* and *Amauroascus echinulatus*. Were this classification to be maintained, it would indicate that keratin degradation is of taxonomically limited usefulness since it does not correlate with morphological characteristics of the peridium.

Keratin degradation involves rupturing the disulphide linkages between the peptide chains of keratin molecules.

TABLE 3 FAMILIES OF THE ONYGENALES

Family	Ascospores	Peridia and Appendages	Anamorphs	Substrate* and Habitats
ONYGENACEAE	 pitted; spherical, oblate, allantoid.		 CHRYSOSPORIUM MALBRANCHEA SPORENDONEMA	carnivore dung soil enriched with keratin or dung KERATIN*
ARTHRODERMATACEAE	 smooth; oblate to oblate-discoid or oblate-convex.		 CHRYSOSPORIUM MICROSPORUM TRICHOPHYTON	decaying hoof, horn, feathers, hair and skin some are parasitic on animals
MYXOTRICHACEAE	 smooth or striate; fusiform, ellipsoid.		 GEOMYCES MALBRANCHEA OIDIODENDRON	processed or decaying plant materials CELLULOSE* paper, straw, soil around the roots of plants
GYMNOASCACEAE	 smooth or slightly irregular ("lumpy"); often with polar and/or equatorial thickenings.		 absent or of un-named arthroconidia.	decaying vegetation soil rich in organic matter VARIABLE* various types of dung

This ability is not widespread. In the fungi, it occurs only in Gymnoascaceae, Onygenaceae (and Cephalothecaceae if we follow Apinis (1968) in placing *Aphanoascus* in this family) and in some hyphomycete taxa with rhexolytically dehiscing conidia. It also occurs in some chytrids (Karling, 1946) and in some actinomycetes. (Davis *et al.*, 1973). Within the filamentous fungi, enzymes able to break the disulphide bridge of keratin molecules probably arose once and their presence among taxa should indicate a high level of relationship. This premise is given weight when it is considered that sexually reproducing fungi with this characteristic, almost without exception, have punctate ascospore walls. Keratin digestion and punctate ascospores, as correlated characters, occur in species exhibiting a spectrum of peridial types from almost absent (in culture) in *Amauroascus*, to hyphal in *Auxarthron* and *Pectinotrichum*, to membranous in *Xynophila* and *Aphanoascus*. Further, these taxa have anamorphs with alternate and/or terminal, rhexolytically dehiscing conidia. These keratinolytic species with reticulate or punctate ascospores are placed in the Onygenaceae.

The exceptions to this correlation are found in the smooth-ascospored genera, *Arthroderma*, *Nannizzia*, and *Ctenomyces* which exhibit pronounced specializations in habitat. The last genus is frequently found on feathers and the first two are either pathogens or saprophytes on mammalian keratin. These three genera are included here in the family Arthrodermataceae. Besides having smooth, minute, oblate ascospores, they also generally produce large, multiseptate conidia (phragmoconidia) (*Ctenomyces* excepted). They are also almost uniformly heterothallic.

With these taxa excluded, nonkeratinolytic species with nonmembranous or mesh-like peridia remain. Within this group, anamorphs are less frequent but continue have similar morphology and dehiscence to the anamorphs of the previous groups.

Myxotrichum, *Byssoascus* and *Pseudogymnoascus* have reddish brown, thick-walled peridial hyphae, strong cellulolytic capacities, and either a simple or dendritic arrangement of alternate, or terminal, rhexolytically dehiscing arthroconidia. Ascospores are hyaline to pale yellow or rose, distinctively fusiform, and either striate or smooth. These genera are placed in a new family, the Myxotrichaceae. Within this family, there are taxa having reduced (or absent) peridia as well as taxa with well-developed, and elaborately appendaged, mesh-like peridia. Von Arx (1981b) has also suggested family status for these taxa.

Remaining is a heterogeneous assemblage of taxa which have questionable taxonomic relationships. This group, assigned here to the Gymnoascaceae, is typified by *Gymnoascus* and includes *Acitheca*, *Arachniotus*, *Gymnascella* and *Gymnoascoideus*. A more appropriate disposition of some of these taxa might well be in the Eurotiales rather than in the Onygenales. The Gymnoascaceae has smooth, mostly oblate ascospores, reduced or mesh-like peridia, and does not exhibit strong substrate preferences. Members are neither keratinolytic nor markedly cellulolytic. Anamorphs have not

SEE ERRATA

been recorded for many species.

The Onygenales then, are circumscribed as follows:

Onygenales Ciferri ex Benny and Kimbrough, 1980, em. Currah.

Ascomata: discrete or confluent, naked or within a more or less specialized secondary structure which may be sessile or stipitate; generally small and white, cream, orange, reddish brown; nonostiolate. **Ascospores:** small, mostly 3-5μm or less in diam., and rarely larger than 8μm at greatest diam., single-celled, lacking germ pores, hyaline or pale (yellow, green, tan, brown); smooth, punctate or punctate-reticulate (may appear spiny with LM), undulate, or striate; globose, oblate, discoid, fusoid or allantoid. **Asci:** membrane quickly evanescent, ascospores usually conglobate (adhering) in groups of 8, rarely fewer; groups globose, ovoid or petaloid. **Peridium:** absent or scarcely differentiated; or mesh-like and composed of thick-walled smooth, asperulate or tuberculate hyphae; or membranous; hyaline or yellow, orange, tan, reddish brown or brown. **Appendages:** absent or well-developed, simple to highly differentiated, usually thick-walled, smooth or tuberculate. **Ascocarp initials:** short coils, usually with a central club-shaped cell ("antheridium") surrounded by a coiled, elongate hyphal branch ("ascogonium"); homothallic or heterothallic. **Anamorph:** absent, or producing hyaline to pale aleurioconidia or arthroconidia, all with rhexolytic dehiscence. **Habitat:** soil, dung, plant debris, paper or processed materials containing cellulose, lichen thalli. Some parasitic on mammals, others associated with birds; frequent on both keratinous and nonkeratinous materials of animal origin or materials associated with animals.

Four families are included in the Onygenales: Arthrodermataceae (*Arthroderma*, *Ctenomyces*, *Nannizzia*), Gymnoascaceae (*Acitheca*, *Arachniotus*, *Gymnoascella*, *Gymnoascoideus*, *Gymnoascus*), Myxotrichaceae (*Byssoascus*, *Myxotrichum*, *Pseudogymnoascus*), and Onygenaceae (*Ajellomyces*, *Amauroascus*, *Aphanoascus*, *Apinisia*, *Ascocalvatia*, *Auxarthron*, *Keratinophyton*, *Kuehniella*, *Nannizziopsis*, *Neogymnomyces*, *Neoxenophila*, *Onygena*, *Pectinotrichum*, *Renispora*, *Shanorella*, *Spiromastix*, *Uncinocarpus*, *Xynophila*). An illustrated summary of the characteristics of the four families is presented in Table 3.

MATERIALS AND METHODS

Materials were obtained from the University of Alberta Mold Herbarium and Culture Collection (UAMH), other herbaria (listed below), and field collections made between 1980 and 1983 from soil, dung, nest and burrow materials found in Alberta. Methods of observation varied with the nature of individual collections.

Herbarium survey: Herbarium accessions in UAMH are cellophane mounts (Carmichael, 1963) of cultures grown on agar plates of several types of media including one or more of the following: Cereal Agar (CER), Oatmeal Agar (OAT)

[=Weitzman and Silva-Hutner, 1967; 'Medium E'], Potato Dextrose Agar (PDA), Phytone Yeast Extract Agar (PYE), (Padhye *et al.*, 1973), and Dextrose Salts Agar with hair (DSA), (Carmichael, 1962). These dried colonies were examined for color, texture, zonation and/or other characteristics of the mycelial mat. Reverse coloration (through the cellophane) was also recorded. In all cases, data were referenced to the age of the mycelial mat and the temperature at which it was grown. Since most UAMH collections are routinely illustrated with *camera lucida* drawings and/or photomicrographs, details from these sources were also recorded. For morphological examinations, and to assist in the preparation of drawings and photographs, fresh slides from dried, cellophane-backed material were made in lactofuchsin (Carmichael, 1955) and/or glycerin jelly (Ainsworth and Bisby, 1971) and examined with the oil immersion objective of the light microscope.

Ability to degrade keratin was based on amount of digestion of human hair on DSA (Carmichael, 1962). Cellulolytic abilities were determined by the extent of digestion and/or weakening of the cellophane film of herbarium preparations.

The "In culture" part of each description is based on a single strain chosen for each species but all UAMH accessions for each species were examined at least briefly and any marked variation is mentioned.

The following herbaria also supplied material for this study.

AMD	Herbarium, Hugo De Vries Laboratorium, Hortus Botanicus.
BM	Cryptogamic Herbarium, Dept. of Botany, British Museum of Natural History, London.
BP	Botanical Department of the Hungarian Museum of Natural History, Budapest.
BPI	U.S. National Fungus Collections, Beltsville, Maryland.
CBS	Centraalbureau voor Schimmelcultures, Baarn.
CDC	Centres for Disease Control, Atlanta, Georgia.
CMI	Commonwealth Mycological Institute, Kew.
DAOM	National Mycological Herbarium, Ottawa.
DBN	Herbarium, National Botanic Gardens, Dublin.
E	Herbarium, Royal Botanic Garden, Edinburgh.
FH	Farlow Herbarium of Harvard University, Cambridge.
FI	Herbarium Universitatis Florentinae, Museo Botanico, Firenze.
G	Herbarium, Conservatoire et Jardin Botanique, Geneva.
HBG	Herbarium, Institut fur Allgemeine Botanik und Botanischer Garten, Hamburg.
K	Herbarium, Royal Botanic Gardens, Kew.
LE	Herbarium, Academy of Sciences of the U.S.S.R., Leningrad.
LPS	Herbario, Instituto de Botanica "C. Spegazzini," La Plata.
MICH	Herbarium of the University of Michigan, Ann Arbor.
MPU	Institut de Botanique, Universite de Montpellier.
NEB	University of Nebraska State Museum, Lincoln.
NRRL	Northern Regional Research Laboratory, Peoria.

NY	Herbarium, New York Botanical Garden, Bronx.
NYS	Herbarium, New York State Museum, Albany.
O	Botanical Garden and Museum, University of Oslo.
OSC	Herbarium, Department of Botany and Plant Pathology, Oregon State University, Corvallis.
PACA	Herbarium Anchieta, Instituto Anchietano e Unisinos, Rio Grande do Sul.
PAD	Istituto di Botanica e Fisologia Vegetale, Orto Botanico, Padova.
PAV	Orto Botanico, Universita di Pavia.
PREM	National Mycological Herbarium, Pretoria.
RSA	Herbarium, Rancho Santa Ana Botanic Garden, Claremont.
S	Herbarium, Swedish Museum of Natural History, Stockholm.
TRTC	Cryptogamic Herbarium, Department of Botany, University of Toronto.
U	Institute for Systematic Botany, Utrecht.
UPS	Herbarium, University of Uppsala.
VER	Erbario Generale del Museo Civico di Storia Naturale, Verona.
WIS	Herbarium, Department of Botany, University of Wisconsin, Madison.

Specimens from these institutions varied greatly in nature. Culture discs, supplied by some herbaria, were examined as for UAMH accessions. Frequently material consisted of dried samples of dung, paper, hoof, horn, feathers etc., with or without an indication as to where the fungus listed on the packet was situated. On most natural materials, structures of other fungi were present. In mixed collections, only the sexual state was recorded. Where quantities were sufficient, glycerine jelly mounts were prepared. Cultures derived from single ascospores are indicated by the abbreviation "SAC." (Accession numbers denoted by "O-" are from G.F. Orr's collections.)

Cultural studies: Only *Gymnascella* isolates were studied comparatively in fresh cultures made specifically for this survey. Observations were confined to growth on cellophane on PDA at 25°C. PDA was the medium of choice for several reasons. Most UAMH cultures of *Gymnascella* had not been grown on this medium and most original descriptions were based, at least in part, on characteristics on PDA. Not only is the medium in widespread use, but it also enhances pigment production, an important taxonomic character. Growth rate, as days from inoculation to total plate coverage, color, texture, and presence or absence of diffusible pigments were the cultural characters recorded.

Microscopic observations of vegetative hyphae, ascomatal initials and features of the ascoma were made by preparing lactofuchsin mounts for examination with the oil immersion objective. Phase contrast microscopy was found to be unsuitable for the examination of thick-walled, refractive structures, such as ascospores, since minute wall irregularities were obscured. Phase was useful for examination of thin-walled conidia where refractive indices of wall material and mounting medium were similar.

Isolation from Alberta substrates: Three methods were used for making primary isolations. The first involved suspending approximately 1 g of ground source material (usually soil or dung) in 1 litre of distilled water. Five ml of the suspension were pipetted onto plates of Mycosel and these were incubated at 25°C in the dark for 4 months, during which time they were examined periodically for teleomorphs. This technique was useful for obtaining *Auxarthron* species. Second, samples of soil from the vicinity of animal burrows were placed in sterile petri dishes, moistened, baited with autoclaved human hair, and incubated as above. These preparations yielded isolates of *Arthroderma* or anamorphs assignable to the Arthrodermataceae. Third, samples (usually of dung) were incubated at room temperature in moist chambers (Malloch, 1981a). This technique yielded the greatest number and diversity of onygenalean fungi. In most cases, whether pure cultures were obtained or not, a permanent slide (glycerine jelly) was prepared from the natural substrate.

Scanning electron microscope (SEM) procedures: Air-dried material from herbarium collections was dusted onto stubs coated with an adhesive ("microstik," Ted Pella, Inc., California). A coating of gold was then applied with either a Nanotech or Edwards sputter coater. Stubs were examined with a Cambridge S-250 SEM and photographed.

Concepts of taxa: The species is defined here as a group of morphologically similar individuals representing a genetic line which propagates itself more or less independently of other such lines (Carmichael *et al.*, 1980). The species I have recognized in the Onygenales are all morphologically distinct from each other except for some in *Arthroderma* and *Nannizzia*. Chief among my criteria are differences in ascospore morphology. Species with similar ascospores (e.g. *Gymnascella aurantiaca, G. afilamentosa, G. citrina*) are recognized by the discontinuity of such characters as ascospore arrangement within the ascus, ascospore shape and color. Species in the genus *Auxarthron* are chiefly delimited on the basis of their peridial characters which are reliably stable. Close inspection of ascospore morphology yields information which complements separations based on peridial morphology for the species of *Auxarthron*.

Genera are recognized by a sudden discontinuity, first in ascospore shape and ornamentation, and second, in peridial morphology.

Families are groups of genera which share degradative capabilities and a common type of ascospore sculpturing (and shape). I have not used peridial morphology to delimit families.

Scope and limitations of descriptions: Descriptions were compiled from the original publication of the names and checked against later treatments in the literature. In nearly all cases I have been able to provide further details, and to edit and improve these descriptions from my observations on materials examined. A major exception to the above occurs with the species of *Arthroderma*, *Nannizzia* and *Ajellomyces*, which, with the exception of *Arthroderma curreyi*, were taken, with some reorganization and editing, directly from the published descriptions. Editing in this case involved standardizing terminology (e.g. changing "bone-shaped" and "ossiform" to ossiform throughout). Where UAMH isolates were available, brief examinations of up to 3 strains each (sometimes more) were made. Cultural characteristics for one of these strains (ideally one isolated from the type collection and termed "type strain") were recorded. The Arthrodermataceae badly needs detailed morphological study.

Dimensions of the microscopic structures given in the descriptions are ranges obtained by examination of several microscopic fields per collection and measurement of a sample judged to be representative. Measurements were taken with an ocular filar micrometer. Where ascospores were not spherical, measurements of largest and smallest diameters were taken.

Format of descriptions: Descriptions are presented in the following standard order: taxon, author, date, publication and illustrations (if any) provided with the original publication of the name. (Except in headings, date of publication follows the reference.) The format is similar for basionyms. References to illustrations provided here are underlined. The type (or lectotype or neotype) is then listed under genus entries. Under species entries, "type material" includes the status and nature of the type, place of origin (country, state or province) and any other relevant data associated with the packet. The rest of each entry is listed in order of taxonomic importance of various features: ascomata, ascospores, asci, peridial hyphae, appendages, anamorph and culture characteristics on 2 or 3 types of media (including CER, DSA, and PYE). For most Gymnoascaceae, characteristics on PDA are also provided. This organization is different from most other treatments which list these items in almost the opposite order. The rationale behind the arrangement used here is that the worker, faced with specimens either in pure culture or on natural materials, (usually) requires ascomata to begin an identification. Secondly, and regardless of the nature of the specimen, ascospores are usually the most important source of taxonomic information. From here one works toward the outside of the ascoma, finally looking at cultural characters.

Next is a section entitled "Notes," with comments on one or more of the following: identification or nomenclatural problems, habitat, remarks on distribution and/or any other noteworthy aspects specific to the taxon.

"Material examined" gives a list of the specimens studied during preparation of the description. These are listed as briefly as possible, in order of: loaning institution (acronym in bold type), number or other identification marks, source material, location and any other relevant information associated with the packet. Unless otherwise stated, materials examined were derived from desiccated cultures.

Identification procedures and use of illustrated tables: There are no dichotomous keys in this treatment. Instead illustrated tables for families and genera are provided. These tables are located in the introduction to each taxonomic part: Table 3 for the four families in the order and Tables 10, 11, 13 and 14 for the genera in each family. Table 12 summarizes the ascospore characters for *Gymnascella* species but I have not provided summaries of the species of other genera. When one is attempting to make an identification, the diagnostic tables permit one to see at a glance which taxon the isolate in hand resembles. Comparison with the detailed description and illustrations should be made for confirmation. For an overall taxonomic appreciation of the groups, the tables quickly convey the chief morphological features involved in each division. For most genera the type species is illustrated. For some genera, e.g. *Auxarthron*, illustrations are provided for additional species.

TAXONOMY OF THE ONYGENALES

Since the application of Luttrell's (1951) developmental concepts to ascomycete classification, many traditional ascomycete families and orders based on gross morphology, have been placed in a state of flux (Alexopoulos and Mims, 1979; Barr, 1983; Benny and Kimbrough, 1980; Malloch, 1981b). Because of this, the identity and position of the order Onygenales among the Ascomycetes merits some discussion.

The subclass Plectomycetidae has been defined by Alexopoulos and Mims to include ascomycetes producing single-celled ascospores in thin-walled evanescent asci that are irregularly disposed (i.e. not forming an hymenium) within a peridium differentiated in the form of a cleistoperidium, or within thin wefts of hyphae which form an arachnoid covering.

The Plectomycetidae is an artificial group, but I am unable at this time to reconcile my own observations with modern systems such as found in Barr (1983) and Malloch (1981b) which suggest more "natural" organizations. Gaumann (1952) recognized 5 families within the order Plectascales and Dennis (1981) placed 8 families in the same order. Alexopoulos and Mims recognize 5 orders in the subclass Plectomycetidae, Ascosphaerales, Elaphomycetales, Eurotiales, Microascales, and Onygenales. This system agrees with that used by Benny and Kimbrough (1980) in their synopsis of the plectomycetes, with the exception that the latter authors split the Microascales into two orders, Monascales and Ophiostomatales.

Malloch (1979; 1981b) proposed a radically different system which reflected a much broader concept of component orders. He distributed the plectomycetes among four major orders: Pleosporales, Hypocreales (including many Eurotiales in the Trichocomataceae), Diaporthales (including Microascales) and Pezizales (including the Monascales and Onygenales as families). His proposal for including Onygenaceae (incl. Gymnoascaceae) in the Pezizales was not supported by Benny and Kimbrough (1980) who noted that pezizalean anamorphs are blastoconidial, cleistocarpous forms have persistent asci with an identifiable operculum, and ascospore shape and ornamentation and sexual organs of established members of the Pezizales are very different from those of the Onygenales.

Both Benny and Kimbrough, and Alexopoulos and Mims recognized the Onygenales as a distinct order within the plectomycetes. Alexopoulos and Mims included only traditional Gymnoascaceae and Onygenaceae. Benny and Kimbrough also included the Dendrosphaeraceae apparently on the basis of arthroconidium production in the type species of *Dendrosphaera*. Kobayasi (1976) figured conidiogenous hyphae which resemble phialides and his description mentions that the anamorph has an apical penicillus of metulae. Since the anamorph is not arthroconidial, this tropical genus should not be included in the Onygenales. Furthermore, *Dendrosphaera* produces rhizomorphs in the soil upon which it fruits and has large ascospores, (17*um* diam.), which are sheathed. Other than its stipitate habit, it has little in common with *Onygena*.

A comparison of the Onygenales with other orders of the Plectomycetidae

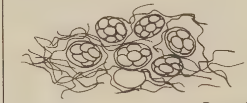
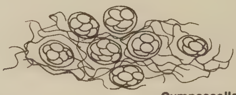
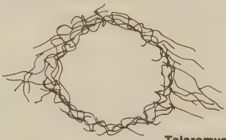
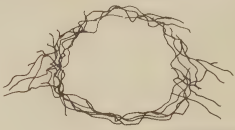
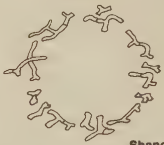
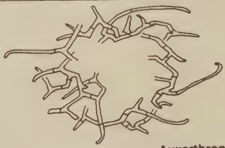
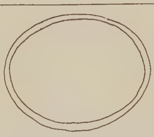
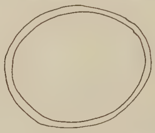
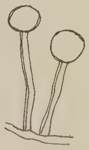
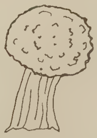
Onygenales and Ascosphaerales: Ascosphaerales (Ascosphaeraceae, *Ascosphaera*) differs from other plectomycete groups in so many respects that Barr (1983) placed the order in its own class, "Ascosphaeromycetes." Most important of these differences is that ascospores are produced in a spore cyst derived from a single cell ("nutriocyte"), i.e., there is no peridium derived from hyphae (Skou, 1982). In addition, the order differs from Onygenales in possessing a sexual apparatus with a trichogyne. It is interesting that this insect parasite has an anamorph similar to the Onygenales.

Onygenales and Elaphomycetales: Alexopoulos and Mims suggest large size (0.5-5cm diam.) and subterranean habit are the main characters distinguishing this order from the Onygenales. In most treatments, the Elaphomycetaceae is considered distinct from the Onygenales. An exception occurs with *Diehliomyces*, an ascomycete with a loose, nonmembranous arrangement of peridial hyphae. It is also reported to be arthroconidial (Gilkey, 1954). Because of the system of *venae internae* (spore-bearing folds) of the centrum and the unique, smooth, spherical, thick-walled, hyaline spores containing a prominent oil droplet (Fig 25b), *Diehliomyces* is excluded from the Onygenales. During my examination of PREM 33387, no arthroconidia were observed. Barr (1983) considered the Onygenales distant from the Elaphomycetales and placed the latter group in the Parenchymatomycetidae.

Onygenales and Microascales: Members of the Onygenales are easily distinguished from the Microascales which have darkly pigmented ascospores with one or more germ pores, and annellidic anamorphs.

Onygenales and Eurotiales: Fennell (1973) included the Gymnoascaceae and Onygenaceae in the Eurotiales. The strongest distinction between these similar groups is in the mode of conidiogenesis. All members of the Eurotiales have

TABLE 4 COMPARISON OF FRUITING BODIES IN THE EUROTIALES' AND THE ONYGENALES

	Eurotiales	Onygenales
Naked asci	 Byssochlamys	 Gymnascella
Telaperidium	 Talaromyces	 Amauroascus
Incompositoperidium	?	 Shanorella
Reticuloperidium	?	 Auxarthron
Cleistoperidium	 Eurotium	 Aphanoascus
Stipitate stroma	 Penicilliopsis	 Onygena

phialidic anamorphs (where connexions have been made). Alexopoulos and Mims refer to the anamorph of *Monascus ruber* (Monascaceae, Eurotiales) as "arthrosporous," The anamorph, *Basipetospora rubra*, has basipetally produced blastic conidia which dehisce schizolytically rather than rhexolytically (Cole and Kendrick, 1968; Cole and Samson, 1979). The families of the Eurotiales are discussed below since the ascomata of this family exhibit a series of morphological types similar to those in the Onygenales (see Table 4).

Amorphotheca, the type and only member of the Amorphothecaceae, was originally considered a member of the Gymnoascaceae (Parberry, 1969). Alexopoulos and Mims suggest that the amorphous, melanoid, membranous peridium of *Amorphotheca* prevents its inclusion in the Gymnoascaceae. More importantly, the anamorph, *Hormoconis resinae*, has darkly pigmented, schizolytically dehiscing blastoconidia in chains.

The monogeneric Cephalothecaceae has phialospores, brown ascospores, and a unique peridial structure not found in other groups.

Many of the Eurotiaceae (Trichocomataceae *fide* Malloch) can be easily mistaken for some genera in the Onygenales. During my studies of material from other herbaria, it was common to find that many species in this group were frequently misidentified as "*Gymnoascus* sp." Kuehn (1958) and Benjamin (1956) included *Byssochlamys*, an organism which produces a scanty peridium of scarcely differentiated hyphae, in their treatments of the Gymnoascaceae. *Byssochlamys* has a distinctive *Paecilomyces* anamorph. *Hamigera* Stolk and Samson is a similar genus but has a *Penicillium* anamorph. *Sartorya* produces distinctive *Aspergillus* anamorphs and forms asci within several layers of loosely interwoven hyphae - a traditional trait of the "Gymnoascaceae." This type of peridium is again encountered in *Talaromyces* which has *Penicillium* anamorphs. Ascospores of *Talaromyces* are distinctly spiny, a feature absent in the Onygenales. Ascospores in many Eurotiaceae have a "pulley-wheel" shape which can be pronounced and quite ornate. Both *Gymnascella confluens* and *Arachniotus ruber* (both treated here in the Gymnoascaceae) produce ascospores with equatorial depressions, and, although they have not been observed to produce phialidic conidia, ascospore shape may eventually support their redisposition in the Eurotiaceae.

Onygenales and Endomycetales: Relationships between these two groups generally have been considered remote. An exception was Redhead and Malloch's (1977) rearrangement of the Endomycetaceae which included arthrosporic *Galactomyces* (incl. *Endomyces*) in the Onygenaceae. Supporting this rearrangement was a presumed relationship based on the association of *Galactomyces* with "animal products" (milk), and ascospores with equatorial grooves. *Galactomyces* has arthroconidia but these dehisce schizolytically. They are also produced with quantities of slime which is in contrast to the dry conidia of onygenalean anamorphs. Further, this genus is not associated with keratinous substrates, ascogenous hyphae do not develop from coiled initials, ascospores develop in groups of less than 8 and have equatorial grooves which are rare in the Onygenales (being present only in a few genera of the Gymnoascaceae with questionable affinities).

Morphological characters in the Onygenales and their taxonomic usefulness

Gametangia: The members of the Onygenales demonstrate a range of diverse peridial types and although mature ascomata have been studied in some taxa, developmental studies in the group are few (Dale, 1903; Dangeard, 1907; Kuehn, 1956; Kwon-Chung, 1973). It is therefore difficult to generalize about their developmental aspects.

Fertile ascomata are initiated by the formation of paired gametangial hyphae which arise from the same or different hyphae of one strain in homothallic species. In heterothallic species, the initials in each pair arise from strains of opposite mating type. Detailed studies on mating behaviour and compatibility systems for members of the Onygenales are few and concentrate on medically important species in the Arthrodermataceae (Aschan-Aberg and Thyresson, 1967; Kwon-Chung, 1972; Maniotis and Chu-Cheung, 1973; Padhye and Carmichael, 1969; 1971; 1973; Sekhon and Padhye, 1976; Stockdale, 1968), and *Ajellomyces* in the Onygenaceae (Kwon-Chung, 1971; 1973). In some instances, the formation of apparently normal ascomata can occur without prior formation of normal initials. These structures, on closer inspection, are sterile and lack ascospores but may sometimes be filled with conidia. The sterile structures have been called "pseudothecia" and occur in all families of the order except the Gymnoascaceae (see Sigler and Carmichael, 1976). Pseudothecium also refers to ascostromatic ascocarps having asci in numerous unwalled locules (Bitunicatae) and therefore the use of this term should be discouraged in the Onygenales. The structures filled with conidia are not usually called pycnidia although a case could be made for so doing.

Events following gametangial pairing are not consistent within families, genera, or even species and accounts vary from one author to another (Kuehn, 1956).

Contact between gametangial branches may be either very simple as in *Uncinocarpus reesii* and *Amauroascus mutatus* (Onygenacaeae) where adjacent tips form "knobs" (Sigler and Carmichael, 1976; Dangeard, 1907 as *Amauroascus verrucosus*), or very elaborate, as in *Gymnoascus reessii* (Gymnoascaceae), where paired gametangia first mutually coil about one another two to three times. One branch then differentiates to become an "ascogenous" branch (archegonial coil) and winds about the club-shaped partner (antheridium). Gametangial contact of an intermediate nature has been observed in *Myxotrichum deflexum* (Myxotrichaceae) (Kuehn, 1956), *Uncinocarpus uncinatus* (Onygenaceae), *Nannizzia incurvata* (Stockdale, 1961), *Arthroderma curreyi* (Udagawa and Furuya, 1977) and *Aphanoascus fulvescens* (Dangeard, 1907). In these taxa, one initial (antheridium) remains relatively straight and clavate while the other (archegonial branch) coils several times about the antheridial axis. Fennell (1973) states that the antheridium of the Gymnoascaceae is often "nonfunctional," referring to the apparent lack of exchange of nuclear material. There is apparently no dissolution of the walls between the gametangia except in very few genera (e.g. *Ajellomyces* McDonough and Lewis, 1968). Asci arise with or without crozier formation and following distal enlargement of both branches and septation of the archegonial coil. These events and/or structures may present valuable taxonomic information at the genus level (Von Arx, 1971; 1974; 1977), but the data are not yet complete enough to make conclusive statements. Much more experimental work is required to assess variability in this phase; Von Arx has limited his observations to very few strains. Such characters have proved useful in other cleistothecial groups, especially the Eurotiales (Benjamin, 1955; Stolk and Samson, 1971; 1972). Certainly some taxa have distinctive gametangia and I have used such data to support removing *Arachnomyces* (See generic names not accepted in the Onygenales).

Peridia and appendages: The peridium in this group has received a great deal of attention since this structure, more than any other, has been used to characterize typical Gymnoascaceae. Reduction of the peridium and homologous structures has occurred in several major groups of ascomycetes including Eurotiales (e.g. *Byssochlamys* and *Hamigera*) and Pezizales (e.g. *Ascodesmis*, *Eleutherascus*). Mesh- or bramble-like peridia also occur in the Eurotiales (*Talaromyces* and allies) (Stolk and Samson, 1972) and *Elaphomyces* (Elaphomycetales). Clearly, membranous peridia are widespread in many different groups of ascomycetes.

In the Onygenales, as in other orders of ascomycetes, peridial characteristics are useful at the genus and species levels. Exclusive reliance on peridial characters can be misleading, since they are quite similar in otherwise very different genera (cf. *Gymnoascus*, *Auxarthron*, and *Uncinocarpus*).

Peridial hyphae (when present) arise from either the base of the antheridial initial and/or from surrounding vegetative hyphae in the immediate proximity to the coil(s). It is not uncommon to observe a number of paired initials within the developing peridium of one ascoma. In *Gymnoascus intermedius* (Gymnoascaceae) and *Myxotrichum bicolor* (Myxotrichaceae), peridial hyphae do not regularly form discrete aggregations, and instead form extensive mat-like ascomata with localized conglomerations of ascospores.

The peridium in many Onygenales is a bramble-like assemblage of more or less differentiated hyphae. There are no reports on the exact organization of these hyphae since, unlike many other groups of ascomycetes, studies using serially sectioned material have not been documented. It is virtually impossible to determine structural features in squash preparations. I have recognized and named 4 types of peridia in the Onygenales: reticuloperidium, incompositoperidium, telaperidium, and cleistoperidium.

TABLE 5 PERIDIAL TYPES IN THE ONYGENALES

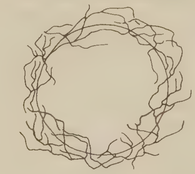
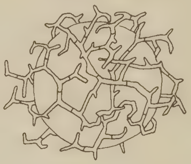
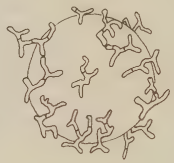
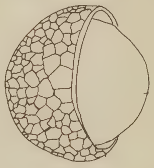
Telaperidium		**Reticuloperidium**	
Incompositoperidium		**Cleistoperidium**	

Table 5 provides diagrams of these peridial types. In general, nonsolid peridia are referred to as "hyphal peridia" and solid peridia are referred to as "membranous peridia."

The **reticuloperidium** is a mesh-like peridium of richly branched and more or less anastomosed, thick-walled hyphae which presumably allow ascospores to sift out through the inter-hyphal spaces. It seems likely that these forms could be adapted to active dispersal by animals, including arthropods, birds and mammals. Most reticuloperidial forms have appendages such as hooks, crooks, coils, spines, or even comb-like structures (*Ctenomyces*) which would serve to latch on to bristles, hairs, feathers etc. (Fig. 6).

In most reticuloperidial Onygenales, distinctive appendages are produced. These may be individual thick-walled hyphae, helices, or in some Arthrodermataceae, macroconidia. In some species there is some question as to where to draw the line between appendages and peridial hyphae. Appendage refers to any differentiated hypha extending beyond the perimeter of the ascoma that is morphologically different from typical vegetative and/or peridial hyphae. Appendages and specialized hyphae associated with ascomata in the Onygenales are illustrated in Table 6.

In some forms, the peridium at maturity is reduced to an apparently unorganized mass of thick-walled, contorted cells. This type of peridium is referred to here as an **incompositoperidium** and occurs in *Shanorella* (Onygenaceae) and in some species of *Gymnascella* (Gymnoascaceae). It may represent a transitional form between the reticuloperidium and telaperidium.

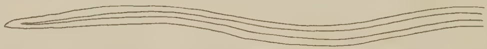
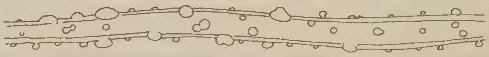
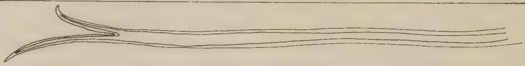
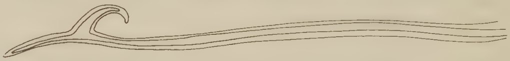
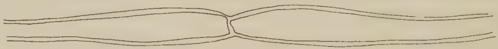
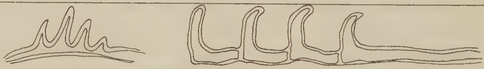
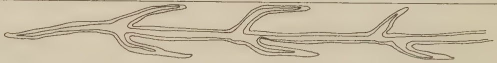
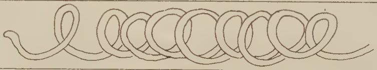
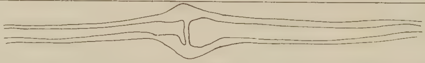
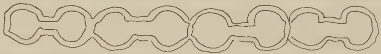
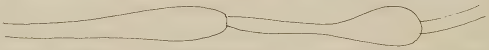
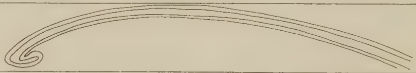
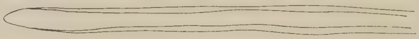
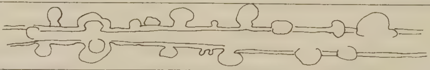
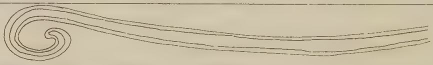
The **telaperidium** is an envelope of thin-walled hyphae that lack any obvious differentiation from the vegetative hyphae. They form a cobweb-like covering over the ascospores. *Byssoascus* (Myxotrichaceae) lacks a peridium typical of other genera in the family. Darkly pigmented hyphae do occur in culture (Sigler and Carmichael, 1976) although these lack any sign of peridial organization. The ascospores are effectively borne amidst apparently undifferentiated vegetative hyphae. In the Onygenaceae, the peridium of *Uncinocarpus reesii* is almost entirely absent, except for dark uncinate hyphae which more closely resemble appendages than peridial hyphae. A similar situation exists in *Ajellomyces* which produces long coils from the centre of the ascoma. In this genus peridial hyphae arise as lateral outgrowths of these coils. Within the Gymnoascaceae, the majority of species in *Gymnascella* lack recognizably differentiated peridial hyphae although some variations may occur depending on strain, age and environmental conditions.

Cleistoperidia are membranous peridia that occur in what I consider primitive forms. This type of construction is found in the Arthrodermataceae (*Ctenomyces*) and in the Onygenaceae (*Aphanoascus*, *Keratinophyton*, and *Xynophila*). The latter genus also possesses a tomentum of closely packed, apparently undifferentiated vegetative hyphae which may enclose one or many ascomata. *Ctenomyces serratus*, when mature, has a membranous peridium immediately surrounding the asci and ascospores. This structure is further enclosed in a thick-walled, mesh-like arrangement of cuticularized hyphae, some of which terminate in typical "ctenoid" appendages. This outer structure could be referred to as a reticuloperidium.

Surface characteristics of mature peridial hyphae are useful for discrimination at the species level. Warts, puncta and even pedicellate structures are common in most Onygenaceae (e.g. *Auxarthron* and *Pectinotrichum*). The peridial hyphae of members of the Gymnoascaceae with rigid reticuloperidia may also be ornamented. Nearly all of the Myxotrichaceae have smooth peridial hyphae. Members of the Arthrodermataceae are almost always ornamented with blunt knobs or protrusions and appear asperulate or tuberculate.

Ascomata: Most ascomata are visible with the naked eye and are frequently greater in diameter than 100μm. Some fruiting structures may be very large. The compound fructifications of *Xynophila* may form cushion-like masses 5-6mm in diameter. *Shanorella spirotricha* forms ascomata enmeshed by hyaline vegetative hyphae and these conglomerations have been measured at 3cm in diameter on natural substrata. *Auxarthron* species nearly always form single ascomata as do most of the Onygenaceae. In the Myxotrichaceae, ascomata are always single except in *Myxotrichum bicolor*. Ascomata in the

TABLE 6 DIAGRAMS OF SOME TERMS APPLIED TO THE PERIDIAL CELLS AND APPENDAGES OF THE ONYGENALES

Term	Diagram
Acute	
Asperulate	
Bifurcate	
Boat hook	
Constricted at septum	
Ctenoid	
Deflexed	
Helix	
Knuckle joint	
Ossiform	
Racquet hypha	
Scimitar	
Tapered	
Tuberculate	
Uncinate	

Arthrodermataceae also occur singly.

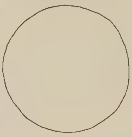
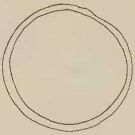
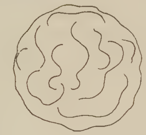
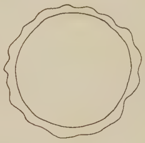
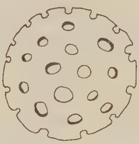
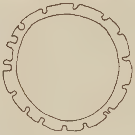
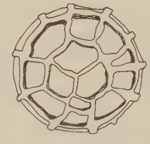
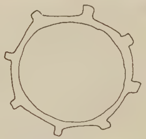
Mature peridial hyphae, whether thin-walled, thick-walled or membranous, may give ascomata distinctive coloration. White to off-white ascomata are comprised of hyaline peridial hyphae. Yellow and pale brown pigments create various shades of cream, yellow, buff or tan. These colors are common in the Arthrodermataceae and Onygenaceae. Although pigments are generally intracellular, some species, particularly in the Gymnoascaceae, produce large quantities of crystalline extracellular pigments which adhere to the peridial hyphae. Bright orange and red pigments, which are mostly crystalline, give *Arachniotus ruber* and *Gymnascella confluens* their characteristic coloration. In fact, most members of the Gymnoascaceae are brightly colored with shades or orange, red and yellow predominating. Green pigments are elaborated in some strains of *Gymnoascus reessii* and in all strains of *Gymnascella hyalinospora*. Reddish brown pigments occur in the peridial hyphae of all of the Myxotrichaceae and in some members of the Onygenacaceae which have membranous peridia (e.g. *Aphanoascus, Keratinophyton*). At the macroscopic level these peridia appear black.

Asci and ascospores: In most Onygenales, the ascus membrane is short-lived and disappears by the time the ascospores are mature. Ascospores are conglobate (remain in typical 8-spored clusters) after membrane dissolution. They separate into individual spores when disturbed. Shape of the ascus is of limited usefulness since nearly all representatives have globose or ovoid asci. Several taxa consistently have ascospore arrangements similar to the petals of a simple, radiate flower. Distinguishing between oblate and spherical ascospores can be done by observing their disposition in ascal clusters; spherical spores make a polygonal arrangement and oblate spores arrange themselves in tight, more or less spherical clusters.

Ascospores are extremely important sources of taxonomic information since morphological variations within taxa are slight in comparison with variations between taxa. Ascospore morphology seems not much affected by environmental factors. Size, shape, color and surface ornamentation are all useful characters in delimiting taxa. Table 7 illustrates some variation in surface ornamentation found in the ascospores of the Onygenales. Table 8 illustrates variations in shape of onygenalean ascospores and asci. Due to their small size (none larger than 8*u*m), details of the ascospores of the Onygenales must be observed with the oil immersion objective.

Ascospores are punctate in all Onygenaceae. These puncta range from very minute in *Shanorella spirotricha* to very large in *Auxarthron californiense*. In the latter case, ascospores appear reticulate and somewhat spiny due to the side views of punctum walls on the perimeter of the spore. Ascospores in this family are never truly spiny although this adjective occurs in virtually all previous treatments of these fungi. *Talaromyces* (Eurotiales) has true spines as does *Aphanoascus cinnabarinus sensu* Udagawa and Takada (1973) (probably Eurotiales). In cases where puncta are very

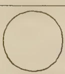
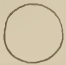
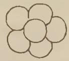
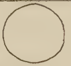
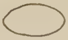
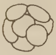
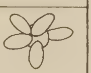
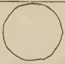
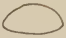
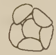
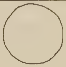
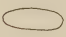
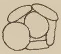
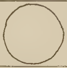
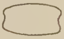
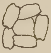
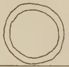
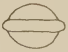
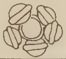
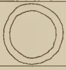
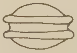
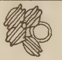
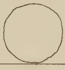
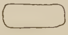
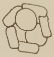
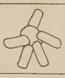
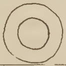
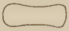
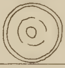
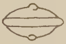
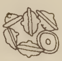
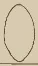
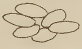
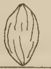
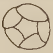
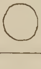
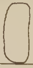
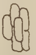
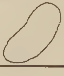
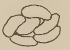
TABLE 7 TYPES OF ASCOSPORE ORNAMENTATION IN THE ONYGENALES

Surface view	Sectional view	Surface view	Sectional view
			
Smooth		Undulate	
			
Punctate		Punctate-reticulate	

small, it is necessary to slowly focus up and down using bright field microscopy. Phase contrast obscures minute puncta and is not recommended for observing ascospores. Spore shape in the Onygenaceae may be allantoid (*Onygena*), oblate (*Uncinocarpus*), bean-shaped or reniform (*Renispora*), or spherical (*Amauroascus*) and in general, shape is useful in distinguishing genera in the absence of contradictory characters. *Auxarthron* exhibits some variation between oblate and spherical ascospores depending on species.

Most of the Myxotrichaceae have striate ascospores. These striae may be very fine or quite distinct depending upon

TABLE 8 ASCOSPORE AND ASCUS SHAPES IN THE ONYGENALES

Ascospore shape	Polar view	Equatorial view	Ascus shape
spherical			
oblate			 
oblate-convex			
oblate-discoid			
oblate with broad equatorial groove			
oblate with 1 equatorial thickening			
oblate with 2 equatorial thickenings			
oblate with poles flattened			 
oblate with polar depressions			" "
oblate with polar and equatorial thickenings			
fusiform			
fusiform striate			
cylindrical			
allantoid	—		

species.

All members of the Gymnoascaceae have smooth or undulate spores which are usually oblate, with or without polar and/or equatorial thickenings.

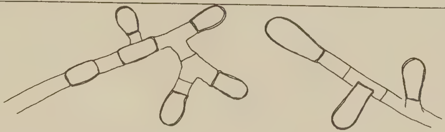
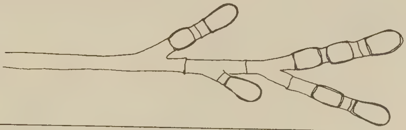
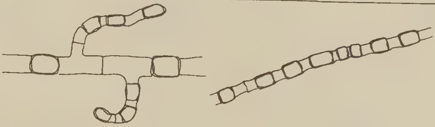
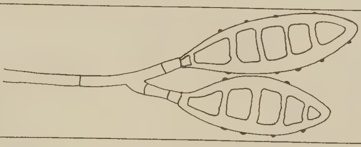
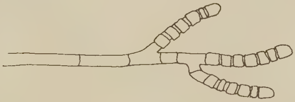
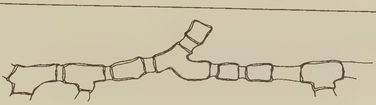
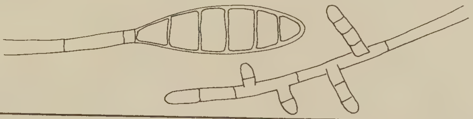
With the exception of *Ctenomyces*, the Arthrodermataceae has very small (usually <3.5um), smooth, ascospores which are oblate-discoid in shape. *Ctenomyces* ascospores have one slightly flattened polar surface. Equatorial modifications are observed only in the Onygenaceae and Gymnoascaceae and these are important sources of distinctive characters at the genus and species levels. *Keratinophyton* has a thickened, raised, punctate equatorial band which is equally thickened in *Keratinophyton durum* and asymmetrically thickened in *Keratinophyton terreum*. In the Gymnoascaceae, equatorial modifications are reminiscent of *Eurotium* species (Eurotiales). In *Arachniotus ruber*, an equatorial depression is bordered by parallel ridges to produce a "pulley-wheel" shape. *Gymnascella confluens* also has a wide equatorial depression. *Gymnascella marginospora*, *Gymnascella punctata* and *Gymnascella dankaliensis* all have a single equatorial rim. *Gymnascella dankaliensis* is further ornamented by a distinct boss on either pole.

Anamorphs: Conidia separate from the hyphae that bear them by two basically different mechanisms (Carmichael, 1971). Hughes (1979) named and defined these mechanisms as follows: rhexolytic: "conidium secession which involves a fracture of the subtending cell," schizolytic: "conidia are liberated from the subtending cell by a split through the outer wall, more or less at the level of the septum delimiting the conidium, and by a splitting of this same septum so that one layer remains on the base of the conidium and the other layer remains on the subtending cell." The great majority of higher fungi have schizolytic dehiscence but only rhexolytic dehiscence is found in the Onygenales.

Anamorph genera associated with the order include: *Chrysosporium* (Carmichael, 1962; Van Oorschot, 1980), *Geomyces* (Sigler and Carmichael, 1976) *Sporendonema* (Samson and Van der Aa, 1973; Sigler and Carmichael, 1976), *Malbranchea* (Sigler and Carmichael, 1976), *Oidiodendron* (Sigler and Carmichael, 1976), *Trichophyton* (Padhye and Carmichael, 1971; Rebell and Taplin, 1970), *Microsporum* (Rebell and Taplin, 1970). All of the named genera except *Sporendonema* have been given detailed taxonomic study during recent years; the references above are to useful treatments. Table 9 illustrates diagrammatically, some of the differences among these anamorph genera. Significant taxonomic characters (size, shape, color and surface ornamentation) vary. In *Trichophyton* (anamorph of *Arthroderma*), and *Microsporum* (anamorph of *Nannizzia*) septation, wall thickness and surface roughening are important characters. In *Geomyces* (anamorph of *Pseudogymnoascus*) the branching pattern of the conidiophore is unique.

With respect to family delimitations, anamorph characters correlate well with teleomorph characters. The Arthrodermataceae is the only family which has multiseptate macroconidia. Although some Onygenaceae will form

TABLE 9 FORM-GENERA IN THE ONYGENALES

Form-genus	Diagram
Chrysosporium	
Geomyces	
Malbranchea	
Microsporum	
Oidiodendron	
Sporendonema	
Trichophyton	

one-septate conidia, none approach the size and complexity of those found in the Arthrodermataceae. In *Nannizzia* and *Arthroderma*, species separation is extremely difficult without considering anamorph characters.

Geomyces, *Oidiodendron* and *Malbranchea* states are found in the Myxotrichaceae. When these occur without typical conidiophores they may be unnamed (Sigler and Carmichael, 1976).

The Onygenaceae frequently produces anamorphs either named in, or assignable to, *Chrysosporium*. Arthroconidia are also common in this group and become well-developed in *Auxarthron* where many anamorphs have been assigned to *Malbranchea*.

Ecological and evolutionary aspects of the Onygenales

Because there is a lack of information on the fossil record of these (and most other) fungi (Pirozynski, 1976), and generally a lack of living material for study for many taxa, some limitations are placed on presenting a phylogeny of the order. Also, I am certain that there are many, as yet undescribed taxa in this group. Information to be derived from these undescribed taxa will have considerable bearing on phylogenetic reconstructions. Further, there are no pertinent ecological treatments. Published work on the ecology of coprophilous fungi shows few records of onygenalean fungi (e.g. Angel and Wicklow, 1983a,b). A recent comprehensive monograph on fungal ecology (Wicklow, 1981) limits discussion of keratinophilic species to one sentence.

The main supposition of the following discussion is that various structural modifications have arisen in response to a reliance on animals for habitat formation and propagule dissemination. I am also assuming that the light-colored ascospores of the Onygenales are more susceptible to damage by ultraviolet light than are more pigmented ascospores of coprophilous Sphaeriales. Susceptibility to ultraviolet light of pigmented and nonpigmented spores of a selection of desert fungi was examined by Durrell and Shields (1960). They found that although pigmentation conferred some

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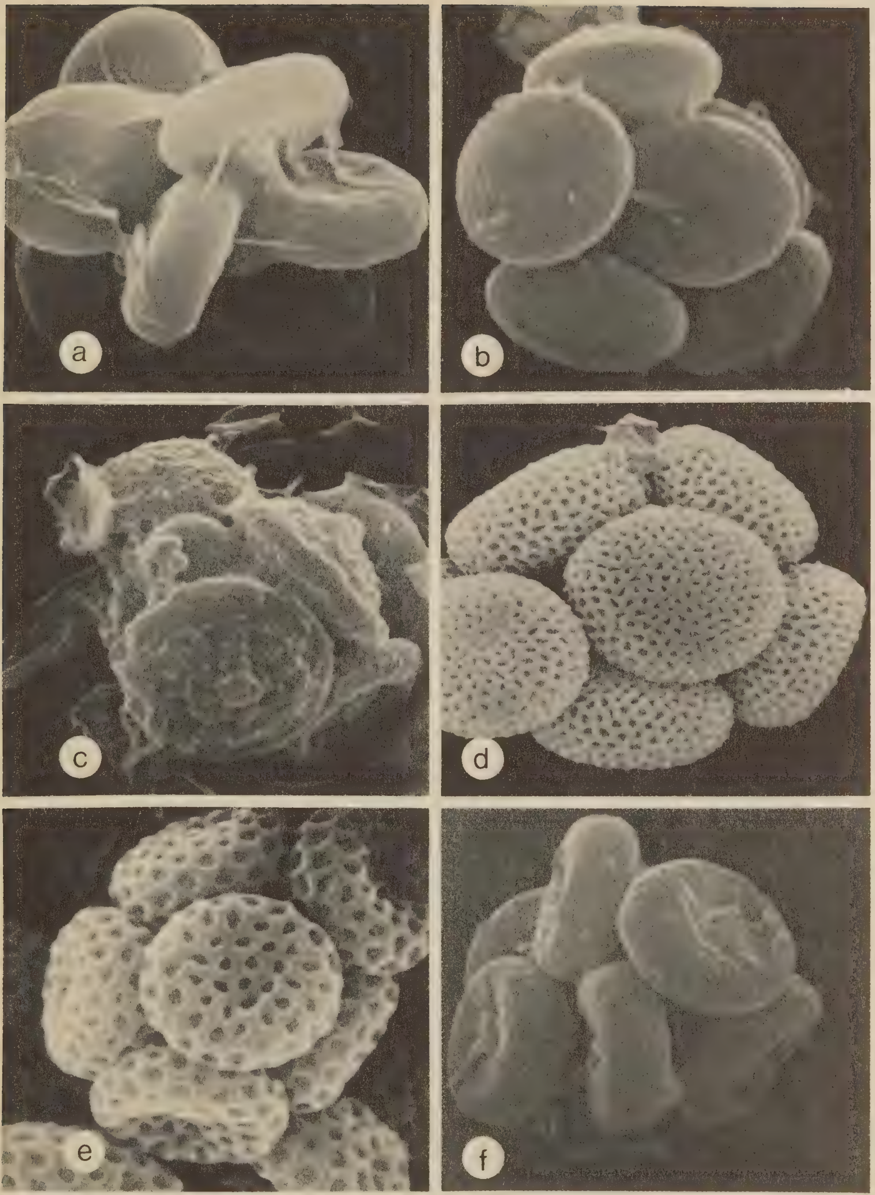
Fig. 1. Ascospore morphology of some Onygenales as seen by SEM. a. *Gymnoascoideus petalosporus* (UAMH 1665) (Gymnoascaceae). Smooth, oblate ascospores in typical petaloid arrangement. X9000. b. *Gymnoascus reessii* (UAMH 1604) (Gymnoascaceae). Smooth, oblate ascospores remaining conglobate following dissolution of ascus membrane. X7560. c. *Gymnascella dankaliensis* (UAMH 3552) (Gymnoascaceae). Irregular-walled ascospores with polar and equatorial thickening. X5220. d. *Xynophila mephitalis* (TRTC HOLOTYPE) (Onygenaceae). Conglobate ascospores oblate with numerous irregular pits. X5040. e. *Auxarthron conjugatum* (UAMH 3156) (Onygenaceae). Conglobate, pitted, oblate ascospores, polar faces slightly concave. X10080. f. *Gymnascella aurantiaca* (TRTC A65C) (Gymnoascaceae). Smooth, oblate ascospores, polar faces concave with slight central bulge. X6840.


a
b
c
d
e
f

protection against ultraviolet light, not all species producing pigmented spores were equally resistant to damage. Effectiveness of the pigments differed depending on their chemical nature. It would be of great biological interest to examine the relative resistances of coprophilous fungal spores to ultraviolet radiation. Results from such a comparative study would have considerable bearing on the interpretation of the relationship of ascospore pigmentation to habitat and dispersal strategies of coprophilous fungi.

All of the Onygenales have hyaline or light-coloured ascospores whereas many other coprophilous groups either have darkly pigmented peridia or darkly pigmented ascospores. Hyaline ascospores are susceptible to damage by ultraviolet light and therefore require protection during development. This can be accomplished in two ways: by expending energy in the production of a protective cover, or by forming meiospores in a protected microenvironment such as an animal burrow. Many insects, as well as other invertebrates, share these and similar habitats and dispersal of burrow-dwelling fungi is probably based on the activities of these cohabitants. Some examples of how peridial structure might have been modified to promote dissemination by animals are presented below.

Onygena is structurally the most complex member of the order. Individual ascomata form within a stalked, stromatic structure which provides a protected environment for meiospore formation. *Onygena equina* is found almost exclusively on hoof and horn. Since ungulates inhabit open areas (grasslands, tundra), their bodies remain in an exposed environment following death. The stromatic nature of the head of *Onygena* provides protection for meiospore development in these exposed situations. After maturation of the ascospores, the stroma ruptures to expose the ascospores. The phototropic stalk ensures that the ascospore mass is not only elevated above the substrate but also that it is in the open. In culture, *Onygena* produces a foul smell which presumably functions in nature as an insect attractant. The likelihood of either the ascospores or the arthroconidia being wind disseminated to another hoof or horn is extremely low. I suggest that *Onygena* is disseminated by insects, probably carrion flies which, in their search for decaying animal products, would serve to transport the fungus to suitable new habitats. This dispersal mechanism finds a parallel in the bryophyte family Splachnaceae, the members of which grow mostly on bones, dung or other decaying materials (Crum, 1976). With reference to the rotten odour produced by *Onygena* in culture, it is significant that many of the other Onygenaceae also produce odours of putrefaction. This attraction device is also demonstrated in the basidiomycete order Phallales.

Ctenomyces serratus (Arthrodermataceae) has distinctive, comb-like appendages which arise from a reticuloperidial layer surrounding an inner membranous peridium. The distance between the tooth-like projections on these appendages approximates the diameter of feather pennulae (Fig. 6b). This taxon demonstrates a marked association with birds. The morphology of the appendages seems ideally adapted to avian dispersal of the ascospores. The pale yellow ascospores are protected from ultraviolet radiation and dessication by the inner cleistoperidium.

In taxa with less differentiated ascomatal structures, the meiospores require an external source of protection. Species in the genera with reduced peridia are adapted to fruiting in underground situations such as found in animal burrows where substrate is plentiful, humidity is high and constant, and damaging ultraviolet light is absent. In these situations, formation of elaborate peridia (and forcible ejection of ascospores - absent in all Onygenales) is a waste of energy. The major biological problem is dispersal and this ultimately rests with the animal inhabitants of the burrow.

The structure of the peridium of genera such as *Gymnoascus* (Gymnoascaceae), *Auxarthron* (Onygenaceae) and *Arachnotheca* (which appears to belong to quite a different taxonomic group based on its unusual sheathed ascospores and proclivity to grow on chitinous materials) seems to be designed either to attach to various animals (arthropods, rodents) or to be disturbed by any type of movement in the vicinity of the ascospore mass. While it is well known that many dark-spored ascomycetes with violently ejected ascospores have a physiological requirement for passage through the guts of herbivorous animals for germination, the explanation for dispersal from feces to feces for predominantly coprophilous Onygenales has much less experimental evidence that gut passage is a requirement for germination (Brierly, 1917; Tubaki, 1960).

Movement from one habitat to another could be effected in much the same way as hypothesized for *Onygena*, i.e. transmission from site to site by insects. Alternatively, colonization of new sites could be effected by gut passage in which case ingestion would probably occur through grooming habits or by ingesting other animals which have come in contact with sporulating colonies.

The biological significance of producing conidia with rhexolytic dehiscence has not yet become apparent. It may have special significance to dispersal mechanisms. The Ascosphaerales, which cause disease of honey bees, produce arthroconidia similar to those of the Onygenales. Similar anamorphs are also found in many families of the order Agaricales (Watling, 1979). Watling felt that they may act, in the Agaricales, as spermatia and that they may also improve competitive ability through the suppression of the growth of other fungi in a given microhabitat. Whether or not these characteristics are specific to this mode of conidiogenesis and subsequent release is unknown.

Cellulolytic Onygenales (Myxotrichaceae) also have reticuloperidia which superficially resemble those in other families of the Onygenales. *Pseudogymnoascus*, primarily a soil-borne fungus, is ocasionally isolated from rhizospheres of higher plants. It has never been implicated as a pathogen and presumably breaks down the cellulosic fraction of sloughed root cells. The reticuloperidium and ascospores are pale rose in color and these characteristics probably indicate a reliance on burrowing animals for dispersal. *Elaphomyces* (Elaphomycetales) which also has a hyphal peridium and a subterranean habit, no doubt has a similar dispersal mechanism. The species of *Myxotrichum* fruit on paper, straw and other cellulosic materials. One taxon, *Myxotrichum bicolor*, fruits on lichens. The dense reticuloperidium is black to the naked eye and this intensity of pigmentation is probably an adaptation to fruiting in exposed situations. The elaborate appendages in this genus appear to be attachment structures to facilitate dispersal by animals.

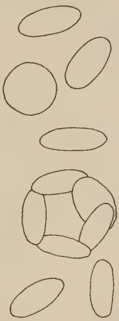
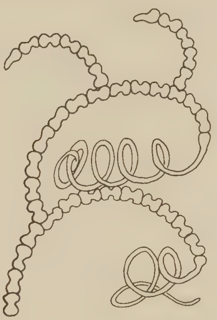
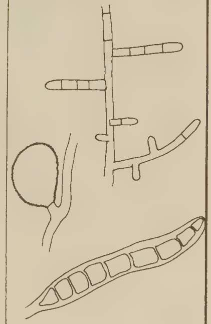
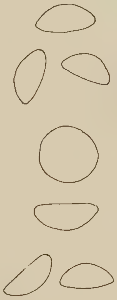
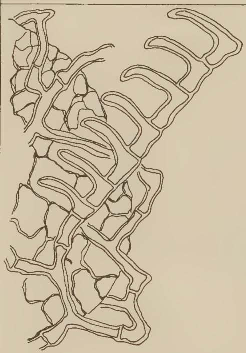
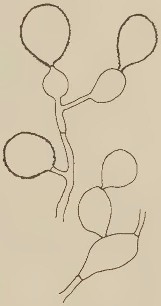
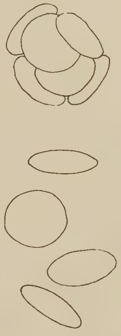
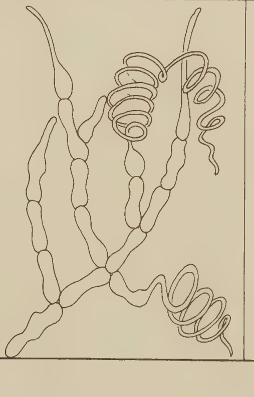
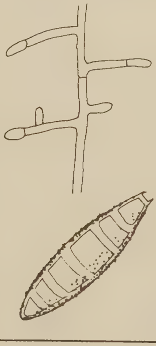
There are some interesting parallels between the parasitic Onygenales and other parasitic fungi. The two keratinolytic families have each developed several pathogenic representatives. In the Arthrodermataceae, many species of *Nannizzia* and *Arthroderma* cause cutaneous diseases of man and other animals. In the Onygenaceae, *Ajellomyces* causes deep mycoses in man. Loss or reduction of structures accessory to meiospore production has also occurred in other parasitic ascomycetes (Taphrinales) and in plant parasitic basidiomycetes (Uredinales, Ustilaginales and Exobasidiales). The basidiomycetous animal pathogen, *Cryptococcus neoformans* (*Filobasidiella*), also has an extremely reduced sexual state. If we follow this progression of reduction in the sexual state, we ultimately come to those pathogens which have never revealed their sexual states. Many of the dermatophytes, especially those which are known only (or primarily) from their hosts, fail to form meiospores in culture. *Coccidioides immitis* which has never shown its sexual state, is almost certainly a member of the Onygenaceae as indicated by its production of arthroconidia with rhexolytic dehiscence. It is also an internal pathogen rather than a cutaneous one.

The Onygenales, although exhibiting some consistent morphological characters, is undoubtedly polyphyletic. I am relatively certain that the families Onygenaceae, Myxotrichaceae and Arthrodermataceae are, internally at least, monophyletic. I feel also that a case may be made for stating that the Arthrodermataceae and Onygenaceae have had a recent common origin. As stated previously, I have reservations about the disposition and relationships of the members of the Gymnoascaceae. Phylogenetic theories in mycology are rather rare when considered against the quantity of this type of speculation with animals and green plants (Wiley, 1981; Funk and Brooks, 1981). In the fungi, stable characters are not only difficult to find but determining polarity (apotypy and plesiotypy) of a given character can become a somewhat arbitrary exercise in the absence of a fossil record. Successful application of cladistic analyses will need to wait until mycology has a better store of basic taxonomic information.

ARTHRODERMATACEAE

Arthrodermataceae Locquin, 1974, ex Currah
Typus *Arthroderma* Berkeley, 1860.

TABLE 10 GENERA OF ARTHRODERMATACEAE

Genus	Ascospores	Peridia and Appendages	Anamorphs
Arthroderma			
Ctenomyces			
Nannizzia			

Ascocarpi nivei, gilvi vel fulvi, globosi, minus 1000um diam., appendiculi exclusi. Ascosporae hyalinae ad gilvae, minutae, levae, oblati, minus 4um diam. Asci subglobosi vel globosi, tenues parietes, transparentes, octospori, minus 7um diam. Hyphae peridii pallido-flavae, septatae, uncinatim ramosae, cellulae ossiformae, brevae aut elongatae, raro textura epidermoidea. Appendicula helicalia septata, parietes leves, aut hyphae elongatae attenuatae, aut hyphae elongatae, crasso-parietales et pectinatae. Heterothallicus. Stat. conid: Chrysosporium, Microsporum aut Trichophyton.

Ascomata: white, pale yellow to yellowish brown, globose, <1000*u*m diam. excluding appendages. **Ascospores:** hyaline to pale yellow, small, smooth, oblate, <4*u*m diam. **Asci:** subglobose to globose, thin-walled, transparent, 8-spored, <7*u*m diam. **Peridial hyphae:** pale yellow, septate, uncinately branched, cells ossiform, short or elongate, rarely forming pseudoparenchyma. **Appendages:** thin-walled, septate and helical and/or elongate and tapered, or thick-walled and pectinate. **Anamorphs:** *Chrysosporium*, *Microsporum* or *Trichophyton*.

This family includes both saprophytic species and dermatophytes, fungi that live as parasites on the skin, hair or nails of man and other animals (many species of *Arthroderma* and *Nannizzia*). *Ctenomyces serratus* has not been shown to be parasitic and is a saprophyte found chiefly in soil and on shed feathers. Diagnostic characters for the 3 genera in the family are presented in Table 10.

Ajello (1968) provides a review of the taxonomic problems with the anamorph names of the dermatophytes. An historical account of the relationship between the teleomorphs and their anamorphs may be found in Ajello (1971). Otcenasek and Dvorak (1975) review an ecological classification which divides the species among the groups designated: "geophilic," "anthropophilic," and "zoophilic" (respectively, nonparasitic saprophytes usually found in soil, pathogens of man, and pathogens of other animals). Isolation from soil is effected by using sterilized hair or other keratin as bait. Isolation from clinical sources is accomplished by using a variety of techniques and selective media (McGinnis, 1980).

Distinguishing taxa within *Arthroderma* and *Nannizzia* in some cases requires morphological information from both teleomorphs and anamorphs, and sometimes mating tests are essential to confirm species identification. For species of medical importance, anamorphs are used for identification. Both genera exhibit species complexes that so far can only be distinguished on the basis of mating behaviour with known testor strains. There is some evidence that morphology of the ossiform cells of the peridial hyphae of these genera may yield some useful taxonomic information. This would probably be a profitable aspect to pursue in future research. Variation in morphology and cultural characters within some species of both genera, coupled with the difficulties of using morphological information for distinguishing between "biological species," pose serious problems for routine identification of species from saprophytic sources.

While the close morphological relationship of *Nannizzia* to *Arthroderma* is obvious, some justification for placing *Ctenomyces* in the Arthrodermataceae is required. In addition to having tiny, smooth-walled, more or less oblate ascospores, the pectinate appendages of *Ctenomyces* appear to be structures homologous to the ossiform cells of *Arthroderma* and *Nannizzia* (Fig. 2). In each case the cell is swollen adjacent to the septum, although in *Ctenomyces* the swelling (forming a hook) occurs only at one end of the cell. In *Arthroderma* and *Nannizzia*, both ends of the cell are swollen. Since these protrusions occur toward the median portion of the cell rather than over the septum, these formations are not comparable to the "knuckle joints" found in *Auxarthron* and *Gymnoascus*. Both the ossiform cells and cells of the pectinate appendage are thick-walled and roughened, and comparable in length and in width of the body of the cell. The *Chrysosporium* state of *Ctenomyces serratus* is strikingly similar in morphology to the *Chrysosporium* state of *Arthroderma tuberculatum*, and the dehisced conidia of the two are easily confused. There is particularly a problem in distinguishing the species on natural substrata, especially if the material is old and dried. In culture, slides can be prepared which show the differences in the conidiophores of the two taxa: the conidia of *A. tuberculatum* have cylindric pedicels while the conidia of *C. serratus* have swollen pedicels. For this reason Van Oorschot (1980) transferred the latter species to *Myceliophthora*. Difficulties in distinguishing between (and among) some taxa in this family have prompted taxonomic investigations in areas other than morphology, particularly for the medically important species. The application of modern taxonomic methods to the systematics of the Arthrodermataceae has been relatively intense when compared to other families in the Onygenales. These studies have involved analysis of proteins (Shechter, 1973; Shechter *et al.*, 1968 a,b; Sekhon *et al.*, 1974; Sekhon and Carmichael, 1976), lipids (Kish and Jack, 1974; Swenson and Ulrich, 1980; Vincent, 1978), carbohydrates (Noguchi *et al.*), antigenic compounds (Andrieu *et al.*, 1966; Christiansen and Svejgard, 1976; Grappel *et al.*, 1970; Philpot, 1978), and pyrolytic components (Brosseau and Carmichael, 1978; Carmichael *et al.*, 1973; Sekhon and Carmichael, 1971; 1972; 1973). Difficulties in obtaining standardized culture material, and technical problems with the methods themselves, have limited the taxonomic value of these investigations. In addition, morphological species complexes seem no less confusing despite the added data from these techniques.

ARTHRODERMA Berkeley, 1860

Outlines of british fungology p. 357.

Type species: *Arthroderma curreyi* Berkeley.

Ascomata: off-white to cream, pale yellow or buff, globose, 200-950*u*m diam., excluding appendages. **Ascospores:** hyaline, yellow in mass, oblate, smooth, 1.5-2.5 x 2.5-3.5*u*m. **Asci**: hyaline, globose, subglobose or ovoid, 8-spored, usually <7*u*m diam., evanescent. **Peridial hyphae:**

hyaline to pale yellow or buff, septate, branched either dichotomously or uncinately; component cells ossiform, usually either symmetrically or asymmetrically constricted, not normally longer than 10-14um, walls moderately thick-walled, minutely to densely asperulate or echinulate. **Appendages:** septate, thin-walled, smooth, long, slender, with helical tips. **Sexuality:** heterothallic (possible exceptions in *Arthroderma curreyi* and *Arthroderma ciferrii*). **Anamorph:** *Chrysosporium* or *Trichophyton*.

Notes: Thirteen species are discussed by Padhye and Carmichael (1971), and are divided into 2 groups based on occurrence of macroconidia. *Arthroderma* is very similar to *Nannizzia* but has shorter ossiform cells and more varied anamorphs.

References: Benjamin, 1956 (*Arthroderma curreyi* and classification of the genus with respect to *Ctenomyces*); Howard, 1983 (Summary of pathogenic species); Padhye and Carmichael, 1971 (Key and line drawings); Pore and Plunkett, 1965 (Biological species concept); Rebell and Taplin, 1970 (Identification manual for dermatophytes); Richardson and Watling, 1969 (Line drawings of ascospores and peridium); Visset, 1973 (SEM).

Arthroderma benhamiae Ajello and Cheng, 1967 Sabouraudia 5:230-232 FIG 1-14.

Type material: HOLOTYPE (*cultura desiccata*) **CDC** B765d (TM20 from human **X** TM17 from dog).

Anamorph name: *Trichophyton mentagrophytes* (Robin) Blanchard, 1896. (see Rebell and Taplin (1970))

Ascomata: off-white, 250-450um. **Ascospores:** 1.2-1.8 x 2.5-2.8um. **Asci:** 3.6-6 x 4.2-7.2um. **Peridial hyphae:** hyaline, dichotomously branched, distal branches curving over the ascoma; cells echinulate, asymmetrically constricted, 4.5-5.2 x 8-12um. **Appendages:** elongate, smooth-walled, tapering at apex, 60-200um; smooth-walled helices. **Anamorph:** Microconidia clavate to subglobose, mostly almost spherical, borne mostly in grape-like clusters from the sides of inflated conidiogenous hyphae that are richly branched at right angles. Macroconidia clavate, 3-5 septate, smooth-walled, 6-8 x 20-50um; rare, or in "granular forms" numerous. (Morphological variation in this anamorph has caused numerous descriptions of distinctive varieties under many species names. These are listed in Padhye and Carmichael, 1971 and Howard, 1983.) **In culture:** [UAMH 2823] CER 14/25°C white, closely appressed, velvety, radiately fibrillose; reverse pale brownish yellow. DSA 42/25°C white, subgranular, margin ragged; reverse uncolored to pale yellow. PYE 21/25°C white to pale cream, thick and felty, radiately fibrillose; reverse reddish to chestnut brown.

Notes: Microconidia provide the most reliable diagnostic feature for this species which is a common agent of numerous types of dermatophytoses in man and other animals. It is worldwide in distribution.

Material examined: UAMH 2823 (-SAC from CDC X798, cultured from holotype 1967).

Arthroderma ciferrii Varsavsky and Ajello 1964 Riv. Patol. Veg. 4:358-359 FIG 1-6.

Type material: HOLOTYPE (*cultura desiccata*) **CDC** B590 (soil from hog pens, Arkansas).

Anamorph name: *Trichophyton georgiae* Varsavsky and Ajello *op. cit.*

≡*Chrysosporium georgii* (Varsavsky and Ajello) Van Oorschot, 1980.

Ascomata: pale ochraceous-salmon to pale vinaceous-brown with age, 450-800*u*m diam. **Ascospores:** 1.5-2.8 x 2.5-3.5*u*m. **Asci:** 4.8 x 6*u*m. **Peridial hyphae:** hyaline, uncinately branched with curled ends; cells symmetrical or asymmetrical, 7-8.5 x 8-12*u*m, (4.2*u*m at constrictions), densely asperulate. **Appendages:** slender, smooth-walled, lateral or terminal helices, and slender, smooth-walled, tapered hyphae, 60-96*u*m long. **Anamorph:** Conidia variable, elongate, clavate, pyriform, subglobose, lateral or terminal, pedicellate or sessile, smooth-walled, 0-3 septate, 2-2.5 x 4-6.5*u*m. **In culture:** [UAMH 2534]. CER 15/25°C buff with vinaceous-brown sectors, felty to granular; reverse pale yellow and vinaceous-brown. DSA 42/25°C sparse white growth; reverse orange to yellow. PYE 28/25°C vinaceous to vinaceous-brown, powdery to granular; reverse brown with irregular spots of dark red or vinaceous-brown.

Notes: This species does not grow at 37°C and is nonpathogenic. It has also been recovered from soil and Opossum hair, Georgia.

Material examined: UAMH 2543, type strain as cited.

Arthroderma cuniculi Dawson, 1963 Sabouraudia 2:187 FIG 2a-h.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** 96243 (rabbit burrow soil, Scotland).

Anamorph name: *Chrysosporium* state of *Arthroderma cuniculi*.

Ascomata: pale yellow, 160-380*u*m diam. **Ascospores:** 1.5-2.8 x 2.5-3*u*m. **Asci:** 3.7-5 x 4-5.4*u*m. **Peridial hyphae:** pale yellow, uncinately branched to the outside of the main branch; cells 3-6 x 5.8-11*u*m, echinulate, becoming 3-4 condylate at maturity (protuberances up to 3.5*u*m long and 1.2-2.7*u*m at the base develop at each end). **Appendages:** septate, smooth-walled, helices with 4-16 gyres, terminal or lateral. **Anamorph:** Conidia variable, hyaline, clavate to pyriform, short-pedicellate, in grape-like clusters, smooth-walled, 1-3-celled, 1.2-2 x 2-7*u*m. **In culture:** [UAMH 1788] CER 14/25°C pale rusty yellow, granular, radiately fibrillose; reverse yellow. DSA 14/25°C buff, thick, localized growth; reverse white. PYE 14/25°C pale yellow to buff, powdery; reverse yellow to brown.

Notes: This species does not grow at 37°C. It is a saprophyte found in soil and dung. Further reports of this species from animal hair, reptile scales, bird pellets, nests and feathers are referenced in Domsch, Gams and Anderson (1980).

Material examined: UAMH 3203/soil/California, coll. Carmichael 1969; 3204/leaves mixed with soil/California, coll. Carmichael 1969; 3586/soil/Manitoba, from J. Reid, Univ. of Manitoba as UM 75.

Arthroderma curreyi Berkeley, 1860 Outlines of british fungology 357.
Figs 6a,c
Type material: None preserved.
≡*Illosporium curreyi* (Berkeley) Saccardo, Sylloge Fungorum 4:660, 1886.
=*Arthroderma xylophilum* Von Hohnel (see Rehm, Ann. Myc. 3:416, 1886).
Anamorph name: *Chrysosporium* state of *Arthroderma curreyi*.

Ascomata: white to pale yellow, discrete to confluent, 100-450*u*m diam. excl. appendages. **Ascospores:** 1.2-2.5 x 2.5-3.5*u*m. **Asci:** 4-5 x 5*u*m. **Peridial hyphae:** hyaline, radiating from the ascoma in a spiral pattern, dichotomously branched (usually to outside of spiral); cells symmetrical or asymmetrical, 2-4 x 3-9*u*m, minutely to densely asperulate. **Appendages:** terminal helices. **Anamorph:** Conidia lateral, sessile to short pedicellate, smooth to rough-walled, clavate to pyriform, unicellular, 1.5-2 x 2.5-6*u*m. **In culture:** [UAMH 4768 (dung, southern Alberta)]. CER 21/25°C pale cream, slightly granular to felty, radiate; reverse uncolored. DSA 42/21°C yellowish cream granular knots of mycelium; reverse uncolored. PYE 21/25°C white to pale cream to buff, flat, floccose; reverse pale yellow to buff.

Notes: This species is a cosmopolitan saprophyte of discarded keratinous materials (hair, feathers, horn etc.). Domsch, Gams and Anderson (1980) reference isolations from soil and leaf litter. This species does not grow at 37°C. Pugh (1964) notes that it is probably not a true soil inhabitant because it cannot grow on unsterilized soil. Sterile ascocarps are common in this species.

Material examined: as "*Ctenomyces serratus*": **FH** Thaxter, 183/feather culture/loc.? (1916); Thaxter 219/horn/Massachusetts (1900); Thaxter 300 (also at **TRTC**)/manure/Maine (1929); Thaxter 506/skunk dung/Maine. as "*Ctenomyces xylophilus*": **FH, HBG, MPU, PACA, TRTC, S** Von Hohnel 1625/decayed wood of *Fagus*/Germany (1902). as *Arthroderma curreyi*: **NY** Pugh/?/loc., from Orr (1965); **RSA** 186/feathers/Massachusetts, coll. Benjamin (1951). **UAMH** 3171/soil/Ohio, coll. Kurup, Ohio State Univ. #SL2 (1969); 3617/skin/Louisiana, Friedman Tulane Univ. School of Medicine, New Orleans 5381-H (1973); 4768/dung/Alberta, coll. Currah (1983).

Arthroderma flavescens Rees, 1967 Sabouraudia 5:206-207 FIG 1a-g.
Type material: HOLOTYPE *(cultura desiccata)* **CMI** 117342 (feathers, south eastern Queensland).
Anamorph name: *Trichophyton flavescens* Padhye and Carmichael, 1971.

Ascomata: pale buff, darker with age, 450-650*u*m diam. **Ascospores:** 1.8-2 x 3.2-4*u*m. **Asci:** 4.8-7.5 x 5.9-8.3*u*m. **Peridial hyphae:** hyaline, with 2 inwardly curving branches arising from some apices; cells asymmetrical, echinulate, 3-4.8 x 11-17um. **Appendages:** smooth-walled, septate, terminal, helical hyphae, 2.7-4.8um wide at the base with up to 22 gyres. **Anamorph:** Microconidia lateral or terminal, smooth, thin-walled, sessile or short-pedicellate, unicellular or occasionally 2-celled, pyriform, ovoid, 4-8 x 5-16um. Macroconidia numerous, hyaline, 2-6-septate, smooth, thin-walled, cylindrical with rounded apices, 8-14 x 26-86um. **In culture:** [UAMH 2933]. CER 14/25°C pale creamy tan; reverse uncolored. DSA 42/25°C white, scant granular growth; reverse uncolored. PYE 14/25°C white to pale buff, dense and felty; reverse bright yellow to yellow-brown.

Notes: This species does not grow at 37°C and is not pathogenic.

Material examined: UAMH 2933/feathers/India, from CMI 117340 (1968).

Arthroderma gertleri Bohme, 1967 Mykosen 10:251 FIG 1ab, 2ab and 3.

Type material: HOLOTYPE *(cultura desiccata)* Mykothek der Univ-Hautklinik, Berlin Nr. 307 (soil, Germany).

Anamorph name: *Trichophyton vanbreuseghemii* Rioux, Jarry and Juminer, 1964. (see Rebell and Taplin (1970))

Ascomata: pale yellow, 200-600um diam. **Ascospores:** 1.5-2 x 2-2.8um. **Asci:** 4 x 5um. **Peridial hyphae:** hyaline, uncinately branched; cells asymmetrical, (occasionally symmetrical), echinulate. **Appendages:** terminal, septate helices varying in length and number of gyres. **Anamorph:** Microconidia pyriform, subglobose, ovoid, thin-walled, unicellular, sessile or on short pedicels, lateral or terminal, 1.5-2.5 x 2-7um, rare. Macroconidia numerous, thin-walled, smooth, cylindrical, multiseptate, borne singly, 6-8 x 30-55um. **In culture:** [UAMH 2620]. CER 14/25°C pale creamy white, cottony, margin fimbriate; reverse bright yellow. DSA 42/25°C scant, yellowish cream, granular, radiately fibrillose, reverse bright yellow. PYE 14/25°C white to creamy white to yellowish buff, radially grooved, velvety; reverse cream to pale buff.

Notes: This species is possibly cosmopolitan (see Howard, 1983).

Material examined: UAMH 566/soil/Alberta, coll. Carmichael (1956); 2620/soil/Germany, -SAC from Bohme (1966); 2998/soil/Alberta, coll. Padhye (1968).

Arthroderma gloriae Ajello, 1967 Mycologia 59:257 FIG 1-12.

Type material: HOLOTYPE *(cultura desiccata)* CDC X778d (soil with keratin, Arizona and N.Mex).

Anamorph name: *Trichophyton gloriae* Ajello, *op. cit.*

Ascomata: pale yellow, 250-450um diam. **Ascospores:** 1.5-2 x 2-2.5um. **Asci:** 3.5 x 4.6um. **Peridial hyphae:** hyaline, uncinately branched; cells echinulate symmetrically constricted, mostly 5 x 7.5um. **Appendages:** moderately slender, thin-walled, pointed, 150um long. **Anamorph:** Microconidia pear-shaped, sessile or short stipitate, 1.5-2.5 x 1.5-6um. Macroconidia numerous, usually in clusters of 4-30, cylindrical, 1-10 septate, smooth, walls to 1um thick, 3-7 x 9-60um. **In culture:** [UAMH 2820]. CER 14/25°C ochre to yellow, granular, radiate; reverse pale yellow. DSA 42/25°C cream-yellow sparse growth; reverse uncolored. PYE 14/25°C ochre, felty to granular; reverse yellow with yellow-brown centre.

Notes: The yellow pigment of this non pathogenic species is more pronounced at 37°C. It is non-pathogenic.

Material examined: UAMH 658/soil/New Mexico, (1959); 2820, +SAC from CDC X779 (1967).

Arthroderma insingulare Padhye and Carmichael, 1972
Sabouraudia **10**:49-50 FIG 1-7.
Type material: HOLOTYPE *(cultura desiccata)* **UAMH** 3443 (soil and chicken feathers, Alberta).
Anamorph name: *Trichophyton terrestre* Durie and Frey, 1957 (complex). (see Rebell and Taplin (1970))

Ascomata: white to pale yellow, 250-500um. **Ascospores:** 1.8-2.2 x 2.5-3um. **Asci:** 3.5-5 x 4-6um. **Peridial hyphae:** hyaline to pale yellow; cells asymmetrically constricted, 5-6 x 8-12um, echinulate. **Appendages:** smooth-walled, septate helices varying in length and number of turns. **Anamorph:** Microconidia clavate to cylindric, borne on undifferentiated hyphae, sessile or on short pedicels, 1.5-3 x 3-6.5um intergrading with clavate to cylindrical, smooth-walled, 1-4 septate macroconidia; (2-celled conidia form in large numbers). **In culture:** [UAMH 3442]. CER 28/25°C grayish yellow to buff, slightly floccose; reverse bright yellow. DSA 42/25°C patchy off-white growth; reverse uncolored. PYE 21/25°C pale buff, floccose, concentrically zonate; reverse yellowish brown.

Notes: This species does not grow at 37°C. It is differentiated from *Arthroderma quadrifidum* and *Arthroderma lenticularum* solely on mating reactions.

Material examined: UAMH 3438, 3439/soil/Alberta, Padhye (1971); 3440/chicken feathers/Alberta, Padhye (1971); 3442 -SAC from 3438 X 3440 (1971); 3455/human hair/Guatemala from Univ. de San Carlos de Guatemala "68C" (1971).

Arthroderma lenticularum Pore, Tsao and Plunkett, 1965
Mycologia **57**:970-971 FIG 1-3.
Type material: HOLOTYPE *(cultura desiccata)* **NY** Pore, Tsao and Plunket #502 (soil on animal keratin, California).
Anamorph name: *Trichophyton terrestre* Durie and Frey, 1957. (complex). (see Rebell and Taplin (1970))

Ascomata: pale buff, 300-600um. **Ascospores:** 1.5-2.5 x 2.2-3um diam. **Asci:** 4-4.8 x 5-5.6um. **Peridial hyphae:** pale yellow, uncinately branched to outside of main hypha; cells symmetrically constricted, echinulate, 5.5-8.5 x 7-10um. **Appendages:** terminal, septate helices. **Anamorph:** Microconidia elongate, pyriform, single or in groups, 1.5-3.5 x 3-6.5um. Macroconidia cylindrical or rarely clavate, smooth, thin-walled, sessile, 2-6-celled, 4-5 x 8-52um with intermediate forms. **In culture:** [UAMH 2931]. CER 14/24°C pale yellow, flat; reverse yellow-brown. DSA 41/25°C white, feathery; reverse uncolored. PYE 14/25°C grayish cream, thick felty, radiately zonate; reverse brownish yellow.

Notes: Colonial morphology is indistinguishable from *Arthroderma quadrifidum* and both have *Trichophyton terrestre* anamorphs. The species are distinguished on the basis of their peridial hyphae: *Arthroderma lenticularum* has symmetrical ossiform cells while *Arthroderma quadrifidum* has asymmetrical ossiform cells.

Material examined: NY Pore, Tsao and Plunket #502/(type as cited). **UAMH** 2931 +SAC from CMI 113772.

Arthroderma multifidum Dawson, 1963 Sabouraudia 2:189 FIG 3a-i.

Type material: HOLOTYPE *(cultura desiccata)* **CMI** 94207 (rabbit burrow soil, Scotland).

Anamorph name: *Chrysosporium* state of *Arthroderma multifidum*.

Ascomata: pale yellow to yellow-buff, globose, 250-550*u*m diam. excl. appendages. **Ascospores:** 1.5-3 x 2.5-3.5*u*m. **Asci:** 4.5-6 x 5-6.5*u*m. **Peridial hyphae:** pale yellow, uncinately branched, usually to outside of main hypha; cells 4-6.5 x 5.8-13*u*m, echinulate, at maturity with 4-8 protuberances up to 1.5-2.5 x 5*u*m, creating a T or Y shape. **Appendages:** septate, smooth, helices, terminal on peridial hyphae. **Anamorph:** Conidia pyriform, subglobose to obovoid, smooth to sparsely rough-walled, 0-1-septate, walls 0.5-1*u*m thick; borne laterally on unswollen pedicels, rarely sessile, 6.6-13 x 8.8-20*u*m. **In culture:** [UAMH 1787]. CER 14/25°C yellowish tan with green tinge, feathery; reverse bright yellow. DSA 42/25°C greenish ochre, granular; reverse tan. PYE 14/25°C sectored. 1. brownish tan, finely granular; reverse bright yellowish tan. 2. bright yellow, granular; reverse pale yellow.

Notes: This species is a soil saprophyte and is probably cosmopolitan. It does not grow at 37°C and there are no records of pathogenicity. A bright yellow pigmentation differentiates it from *Arthroderma tuberculatum*.

Material examined: UAMH 1977/pasture soil/Czechoslovakia, Kunnert, Palaky Univ. Olomouc CH 8 (1964); 1787 +SAC from type, obtained from C. O. Dawson, Glasgow (1963);2708/soil/Roumania, Alteras, Central Dermato Venerologic Bucharest #3 (1967); 2783/gopher burrow/Alberta, Remington, Edmonton (1967); 4600/soil/Spain, Guarro, Univ. of Barcelona, FFBA 340 (1982); 4766/bottom sediments of polluted pond/Poland, Ulfig, Katowice No 4 (1983).

Arthroderma quadrifidum Dawson and Gentles, 1961 Sabouraudia 1:55-56 FIG 2a-e.

Figs 3a,b,c,d

Type material: CMI?

Anamorph name: *Trichophyton terrestre* Durie and Frey, 1957. (complex). (see Rebell and Taplin (1970))

Ascomata: pale buff, 400-700*u*m diam. **Ascospores:** 0.9-2.2 x 1.8-3*u*m. **Asci:** 3.5-5 x 4-6*u*m. **Peridial hyphae:** pale yellow, uncinately branched to outside of main hypha; cells 5-9 x 8-13*u*m, strongly echinulate, at maturity condylate on one face. **Appendages:** terminal or lateral, septate helices varying in length and number of gyres. **Anamorph:** Microconidia elongate, pyriform, single or in groups, 1.5-3.5 x 3-6.5*u*m intergrading with cylindrical or rarely clavate, smooth, thin-walled, sessile, 2-6-celled macroconidia, 4-5 x 8-52*u*m. **In culture:** [UAMH 1686] CER 14/25°C white, granular; reverse uncolored. DSA 33/25°C ash-gray, dense in restricted patches; reverse uncolored. PYE 14/25°C gray to off-white, fluffy to powdery when dried, zonate; reverse reddish to yellow-brown.

Notes: First isolated from soil, horse and rat hair, this species has since been recovered from soil, Belgium (Ajello *et al.*, 1965), Galapagos Islands (Ajello, 1974) and is probably cosmopolitan although Domsch, Gams and Anderson (1980) note that it may have a preference for subtropical and temperate zones. It has also been reported from a wide range of substrates including soil, skin-scrapings and feathers; Dawson and Gentles have isolated it from a ring-worm lesion on a squirrel. Under experimental conditions it may cause infections (see Domsch, Gams and Anderson (1980)) otherwise it is not commonly pathogenic. This species does not grow at 37°C.

Material examined: UAMH 544, 565/soil/Alberta, coll. Carmichael (1959); 669/lung of *Citellus richardsonii*/Alberta, coll. Carmichael (1960); 755/soil of pig yard/Alberta. 760/soil from chicken run/Alberta, coll. Carmichael (1960); 790/skin of human foot/Alberta, coll. Carmichael CP60-974 (1960); 824/hedgehog hair/New Zealand, Marples, Univ. of Otago (1960); 864/soil/Hungary, Georg (1961); 1328/badger soil/Alberta, coll. Carmichael, 18-8-ax; 1686/soil/Alberta, coll. Carmichael (1963); 2125/human foot/Alberta, coll. Carmichael MY 2061-64 (1964); 2703/hair and skin scrapings from cat/Alberta, coll. Carmichael MY 3222 (1966).

Arthroderma simii Stockdale, Mackenzie and Austwick, 1965
Sabouraudia 4:113-114 PL 1a-e, FIG 1 a,b.

Type material: HOLOTYPE *(cultura desiccata)*. **CMI** 93944 (chicken, India).

Anamorph name: *Trichophyton simii* (Pinoy) Stockdale, Mackenzie and Austwick *op. cit.*

Ascomata: pale buff to buff, 200-700*u*m diam. **Ascospores:** 1.5-2.5 x 2.5-3.5*u*m. **Asci:** 5-6.7*u*m diam. **Peridial hyphae:** pale buff, up to 3 secondary branches arising from one cell, distal branches curve over ascoma; cells 3-4.5 x 13-21*u*m, ends giving rise to branches 5-7.5*u*m diam. Outermost branch cells asymmetrical, echinulate, 4.2-6.7 x 6.5-13*u*m. **Appendages:** slender, smooth-walled, septate helices. **Anamorph:** Microconidia more numerous with age, clavate to pyriform, 1.5-4 x 2-6.5*u*m, sessile to substipitate, in clusters. Macroconidia numerous, terminal on branched hyphae, hyaline, smooth-walled, fusiform to cylindrofusiform, 6-11 x 30-80*u*m, 4-10-sepate, constricted at septa with age to form thick-walled chlamydospores. **In culture:** [UAMH 2944]. CER 42/25°C grayish tan, felty; reverse buffy brown. DSA 42/25°C tan in localized felty patches; reverse uncolored. PYE 14/25°C white, cottony with yellowish brown patches; reverse pale reddish brown.

Notes: Helical hyphae are moderately abundant on vegetative mycelium of old cultures. This species grows at 37°C and is pathogenic to man, monkeys, dogs and poultry. It has also been reported from India, Brazil and Nigeria.

Kwon-Chung (1972) presents a study of incompatibility in this species.

Material examined: UAMH 2944 -SAC from CMI 98944 from poultry, India (1968).

Arthroderma tuberculatum Kuehn, 1960 Mycopathol. et Mycol. Appl. 13:190 FIG 1-15.

Figs 2a,b

Type material: HOLOTYPE (*cultura desiccata*) **NRRL** (robin feathers, Illinois).

Anamorph name: *Chrysosporium* state of *Arthroderma tuberculatum*.

≡*Myceliophthora* state of *Arthroderma tuberculatum fide* Van Oorschot, 1980.

Ascomata: creamy white to cream-yellow, 430-970*u*m diam. **Ascospores:** 1.5-1.8 x 2.8-3.2*u*m. **Asci:** 3.9-4.7 x 4.5-5.5*u*m. **Peridial hyphae:** pale yellow, uncinately branched to the outside of main hypha; cells symmetrical or asymmetrical 6-7 x 10-27*u*m (4*u*m wide at constriction), densely asperulate. **Appendages:** slender, septate, hyaline, smooth-walled, terminal helices. **Anamorph:** Conidia aseptate, terminal or lateral, borne on short unswollen pedicels or sessile, subglobose, ovoid, pyriform with a thick, tuberculate wall, 7-10 x 10-15*u*m. **In culture:** [UAMH 3181]. CER 28/25°C pale yellow, granular; reverse orange-tan. DSA 42/25°C white, sparse; reverse uncolored. PYE 7/25°C cream to pale yellow, granular to felty; reverse orange-tan.

Notes: This species is cosmopolitan and has been isolated from from soil, feathers, hairs, bird's nests, bat dung (see Domsch, Gams and Anderson (1980)) and onychomycoses (Rippon, 1974). It does not grow at 37°C.

Material examined: UAMH 1724/soil/British Columbia, coll. Carmichael (1963); 1967/soil/Argentina, Varsavsky EV&A (1964); 3147/finger lesion/California, Orr 2503 (1969); 3181, isolated from type strain CMI 86177 (1969); 4589/soil/Spain, Guarro, Faculty of Medicine, Univ. of Barcelona FFBA 216 (1982).

Arthroderma uncinatum Dawson and Gentles, 1961 Sabouraudia 1:55 FIG 1a-g.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** (soil, Scotland).

Anamorph name: *Trichophyton ajelloi* (Vanbreuseghem) Ajello, 1968.

Ascomata: pale buff, 300-900*u*m diam. **Ascospores:** 1-1.8 x 2.5-3.2*u*m. **Asci:** 5-6.5 x 5.4-7.2*u*m. **Peridial hyphae:** hyaline to pale yellow, uncinately branched to the outside of the main hypha; cells 4-7 x 7-11*u*m, strongly echinulate. **Appendages:** septate, smooth-walled helices, terminal, variable; occasional smooth-walled, multiseptate, fusiform macroconidia are produced by peridial hyphae. **Anamorph:** Microconidia present in some strains; pyriform to obovoid, 2-5 x 3-9*u*m. Macroconidia abundant, cylindric, fusiform, 8-12 septate, thick-walled, smooth, 8-12 x 18-60*u*m. **In culture:** [UAMH 2759]. CER 7/25°C centre yellow, margin broad and white; reverse yellow. DSA 42/25°C yellowish cream, localized; reverse uncolored. PYE 7/25°C cream to orange-tan, powdery; reverse uncolored. (Pigmented forms can be vinaceous-red or bluish black.)

Notes: A widespread soil inhabitant, this species has been recovered from soil, Belgium (Ajello *et al.*, 1965), hair of wild rats, and from a lesion on a horse. Domsch, Gams and Anderson (1980) list bird nests, hair and skin scrapings as sources. Rippon (1974) reports it from cattle, dogs and squirrels but it is a rare pathogen of humans. In culture, formation of sexual structures is inhibited at temperatures above 25°C and there is no growth at 37°C.

Material examined: UAMH 557/soil/Alberta, coll. Carmichael (1956); 739, 740/soil/Alberta, coll. Carmichael (1960); 750/sheep wool/Alberta, coll. Carmichael (1960); 1315/soil/Alberta, coll. Carmichael, 18-8-a (1962); 2759/soil/Alberta, coll. Carmichael (1967).

Arthroderma vanbreuseghemii Takashio, 1973 Ann. Soc. Belge. Med. Trop. **53**:547-548 **FIG** 77-83, 86.

Type material: HOLOTYPE *(cultura desiccata)* **CBS** RV 27960 X 27961. (testor strains, origin undetermined).

Anamorph name: *Trichophyton mentagrophytes* (Robin) Blanchard, 1896. (see Rebell and Taplin (1970))

Ascomata: straw or buff-colored, 300-650*u*m diam. **Ascospores:** 1.5-1.8 x 2.5-2.8*u*m. **Asci:** 3.6-6 x 4.2-7.2*u*m. **Peridial hyphae:** hyaline to buff, dichotomously branched; cells asymmetrically constricted, echinulate, 4.5-5.2 x 8-12*u*m. **Appendages:** elongate, smooth-walled hyphae tapering at the apex, 60-200*u*m long; and smooth-walled, helical hyphae with up to 15 gyres. **Anamorph:** Microconidia clavate or spherical, lateral (forming clusters). Macroconidia clavate, 3-5-septate, smooth-walled, 6-8 x 20-50*u*m; rare, or in "granular forms" numerous. (Morphological variation in this anamorph has engendered numerous descriptions of distinctive varieties under many species names. These are listed in Padhye and Carmichael, 1971 and Howard, 1983.) **In culture:** [UAMH 3740]. CER 14/25°C pale yellow-buff, granular; reverse yellowish to uncolored. DSA 42/25°C pinkish buff, sparse scattered. PYE 14/25°C pinkish buff, dense granular, margin irregular; reverse reddish tan to reddish brown.

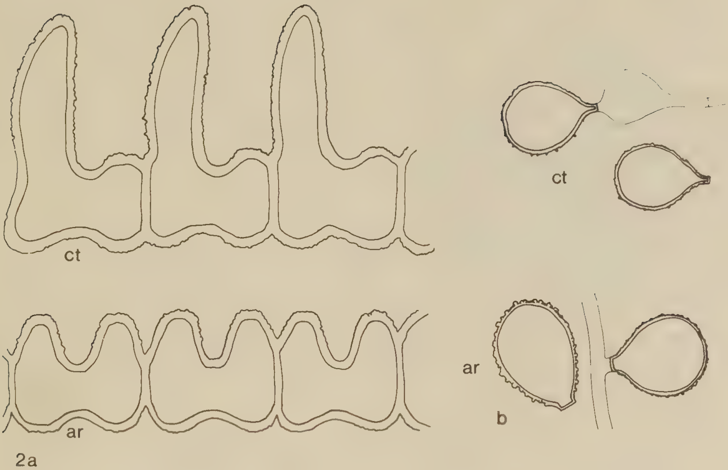
Notes: This species is distinguished from *Arthroderma benhamiae* by mating reactions. The latter species also has slightly smaller ascospores.

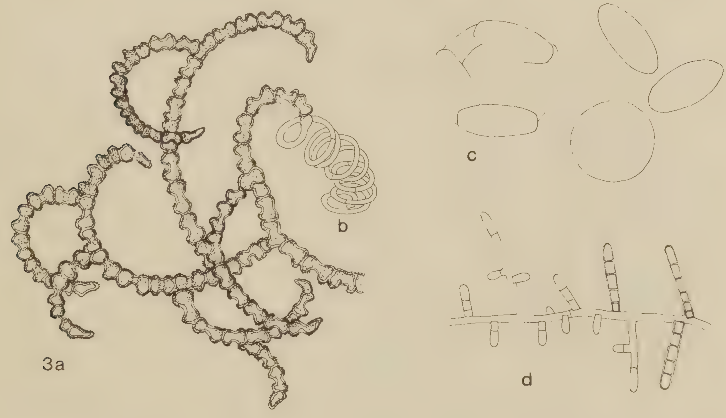
Material examined: UAMH 3740/human/France, Badillet and Rivalier, from ATCC 24956, =RV 27435.

CTENOMYCES Eidam, 1880
in Cohn, Beit. Biol. Pfl. 3:274.

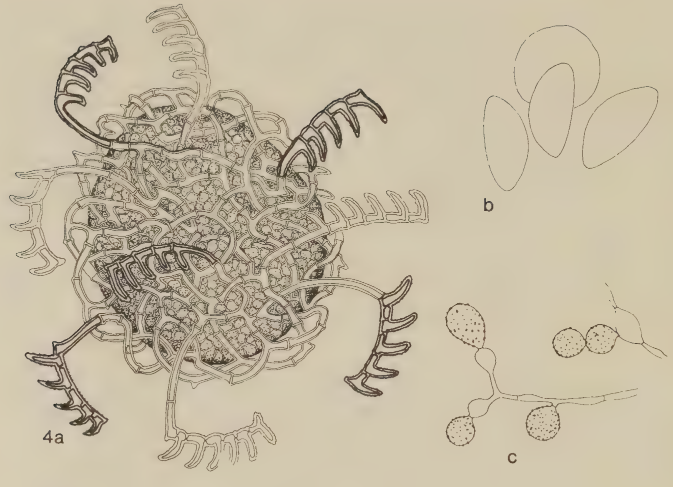
Type species: *Ctenomyces serratus* Eidam em. Benjamin

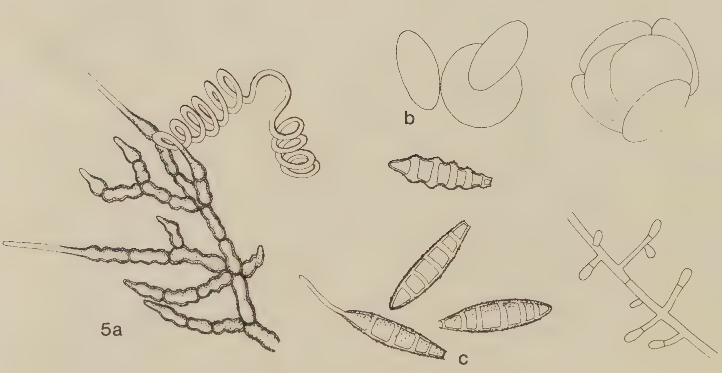
Ascomata: orange-brown, globose, 100-350*u*m diam. excl. appendages. **Ascospores**: pale orange, oblate-lenticular (one side flattened), smooth, 2-2.6 x 3.3-3.6*u*m. **Asci**: hyaline, ±globose, 8-spored, <7*u*m, evanescent. **Peridial hyphae**: pale orange, membranous inner layer of thin-walled, hyphae; outer layer of orange-brown, septate, thick-walled, echinulate to asperulate hyphae which form a reticuloperidium. **Appendages:**





Figs 2-3. 2. Diagramatic comparison of cell morphology in *Arthroderma tuberculatum* and *Ctenomyces serratus*. a. A section of a peridial hypha of *Arthroderma tuberculatum* ('ar') and a section of a ctenoid appendage of *Ctenomyces serratus* ('ct'). X940. b. The conidia and conidiogenous cells of the anamorphs of *Arthroderma tuberculatum* ('ar') and *Ctenomyces serratus* ('ct'). X185. 3. (*Arthroderma quadrifidum* (UAMH 1686)). a. Peridial hyphae of thick-walled, echinulate, ossiform cells. b. Terminal, thin-walled, smooth, septate, coiled appendage. a & b X470. c. Ascus and individual smooth-walled ascospores. X3995. d. Anamorph *Trichophyton terrestre* s. l., with thick-walled, 0-multiseptate conidia. X705.





Figs 4-5. 4. *Ctenomyces serratus* (TRTC Thaxter 173). a. Ascoma with pseudoparenchymatous inner peridium surrounded by thick-walled reticuloperidial hyphae bearing roughened, pectinate appendages. X118. b. Smooth-walled, oblate ascospores with one flattened pole. X415. c. Rough-walled conidia of anamorph, *Chrysosporium* state of *Ctenomyces serratus*; conidia borne on thin-walled, inflated, vesicular cells. X110. 5. *Nannizzia incurvata* (UAMH 1484). a. Peridial hyphae of thick-walled, echinulate, ossiform cells with 1-3 slight constrictions and a thin-walled, coiled appendage. X470. b. Smooth-walled, oblate ascospores and ascus. X2880. c. anamorph of *Microsporum gypseum*; microconidia one-celled, clavate; macroconidia roughened and septate; uppermost macroconidium collapsed between septa. X410.

pale orange-brown, septate, thick-walled, asperulate, recurved, tooth-like protuberances lining one side. **Sexuality:** heterothallic. **Anamorph:** *Chrysosporium*.

Notes: This species was first described as a resting or sclerotial phase of *Arthroderma curreyi* by Eidam, 1880, but Benjamin (1956) clarified the identity of the two taxa.

References: Benjamin, 1956 (Taxonomy with respect to *Arthroderma*); Frey and Griffin, 1961 (Anamorph); Orr and Kuehn, 1963 (Review of genus and list of excluded species); Varsavsky and Reca, 1964 (Sexuality); Sekhon and Padhye, 1976.

Ctenomyces serratus Eidam, 1880 Cohn, Beit. Biol. Pfl. 3:274, 1880 PL XII fig. 2. em Benjamin El Aliso 3:307-311, 1956 PL V.

Figs 2a,b 4a,b,c 6b,d

Type material: NEOTYPE *(cultura desiccata)* **CMI** 86199 (soil, Australia) *fide* Durie and Frey (1962).

Anamorph name: *Chrysosporium* state of *Ctenomyces serratus*. =*Myceliophthora* state of *Ctenomyces serratus fide* van Oorschot, 1980.

Ascomata: orange-brown, 100-350um diam. **Ascospores:** pale orange, lenticular, asymmetrical, flattened on one side, 2-2.6 x 3.3-3.6um. **Asci:** 4-6 x 5-6um. **Peridial hyphae:** membranous inner layer of pale orange, thin-walled, densely interwoven, hyphae, 3.3-6um diam. surrounded by orange-brown, thick-walled hyphae. (Inner layer forms a cleistoperidium; outer layer forms a reticuloperidium). **Appendages:** ctenoid, 100-150um long, 5-11 cells, asperulate, hooked, 26-38um in length. **Anamorph:** Conidia hyaline to buff in mass, obovoid to globose, verrucose, 7-9 x 10-17um (resembles *Chrysosporium asperatum fide* Carmichael (1962). **In culture:** [UAMH 1588]. CER 21/25°C yellow with white margin, slightly radiately fibrillose; reverse pale yellow with darker yellow spots. DSA 62/25°C pale, scant, feathery; reverse uncolored. PYE 21/25°C tan-colored, margin white; reverse dark reddish brown, margin pale yellow.

Notes: This species is world-wide in distribution and has a strong predilection for feathers but it has also been found on dung and in soil (Easter Island (Ajello and Alpert, 1972), New Guinea (Durie and Frey, 1962), Galapagos (Ajello and Padhye, 1964). Grin and Ozegovic (1963) and Pugh (1974) consider the taxon a soil saprophyte. It is not pathogenic to guinea pigs under experimental conditions (Frey and Griffin, 1961).

Material examined: UAMH (soil isolates of *Chrysosporium* state of *Ctenomyces serratus*): 1115, 1116/California, G. F. Orr (1961); 1570/Australia, Griffin (1963); 1588/England, Dickinson (1963); 1958/India, Rhandhawa '62 (=Orr SL 466) (1964); 1959/England, Dickinson (O-3012) (1964); 1960/India, Randhawa (=Orr SL85) (1964); 1961/Argentina, M. Reca (1964); 1968/sand dunes/England, Pugh '61 (=Orr 3019) (1964); 2830/India, Padhye (1967); 3197/England, Dawson, CMI 89563 (1969); 3622/Argentina, Varsavsky, (O-2) (1973); 4429/India, Jain, Dept. of Botany, Saugar CP-19 (1981). **FH** Thaxter 166 (also in TRTC)/feathers/Cuba (1903-4); Thaxter 173 (also in TRTC)/feathers/Massachusetts [cultured feathers]; Thaxter

175 (also in TRTC)/feathers/Panama [cultured feathers] (1916); Thaxter, 188/feathers/Panama [cultured feathers]; Thaxter 217/dung culture/Massachusetts; Thaxter 312/Ass dung/Russia [cultured dung].

NANNIZZIA Stockdale, 1961
Sabouraudia 1:45-46 PL 1a-e.

Type species: *Nannizzia incurvata* Stockdale *op. cit.*

Ascomata: pale buff to yellowish buff, 350-500um diam. **Ascospores:** hyaline, yellow in mass, oblate, smooth-walled, 1.5-2 x 2.8-3.5um. **Asci:** hyaline, globose, subglobose, ovoid, 8-spored, usually <7um, evanescent. **Peridial hyphae:** hyaline, septate, verticillately branched hyphae; component cells elongate, ossiform, moderately thick-walled, densely asperulate, ±symmetrically constricted. **Appendages:** of two types: 1. elongate, slender, smooth-walled, septate, occasionally branching, straight or loosely coiled hyphae; 2. elongate, slender, smooth-walled, septate, occasionally branching, tightly coiled hyphae. **Anamorph:** *Microsporum*; (*Chrysosporium* in one doubtful taxon).

References: Domsch, Gams and Anderson (1980) (Key to some of the species); Padhye *et al.*, 1973 (Culture); Padhye and Carmichael, 1972 (SEM of ascospores); Rebell and Taplin, 1970 (Identification manual for dermatophytes); Weitzman *et al.*, 1970 (Chromosome numbers).

Nannizzia borellii Padhye and Ajello, 1975 Mycologia 67:1112 FIG 1-6.

Type material: HOLOTYPE (*cultura desiccata*) CDC B-2093. (hair of spiny rat, Brazil).

Anamorph name: *Microsporum amazonicum* Moraes, Borelli and Feo, 1967.

Ascomata: dull white or pale yellow, 300-500um. **Ascospores:** 2-2.5 x 2-3um. **Asci:** 4-5um. **Peridial hyphae:** hyaline, dichotomously branched; cells finely echinulate. **Appendages:** elongate, septate, smooth-walled, tapering hyphae to 150um long, 2-3um diam. at base and 1.2-1.5um at tip; elongate, smooth-walled, slender helices. **Anamorph:** Microconidia clavate, 1.6-2.3 x 4.5-6um. Macroconidia symmetrical, spindle-shaped, echinulate to bristly, thick-walled, 1-4-septate, 10-15 x 25-37um. **In culture:** [UAMH 3752]. CER 14/25°C olive-brown, scattered knot-like growths; reverse uncolored to very pale yellow. DSA 42/25°C scattered knots of dark olive-brown mycelium; reverse uncolored. PYE 14/25°C olive-brown, velvety, radiately grooved; reverse pale yellow.

Notes: This species has been isolated from hair of a spiny rat *Proechimys guyannensis* and from a rat in the genus *Oryzymys*. Probably saprophytic according to Howard, 1983.

Material examined: UAMH 3752 -SAC from CDC Y-82 derived from type (1974).

Nannizzia cajetani Ajello, 1961 Sabouraudia 1:175 FIG 1a-f, 2a-d.

Type material: HOLOTYPE (*cultura desiccata*) **CDC**? (soil, Kentucky).

Anamorph name: *Microsporum cookei* Ajello, 1959.

Ascomata: pale yellow, 390-690um diam. **Ascospores:** golden in mass, 1.5-1.8 x 3-3.6um. **Asci:** 6-9um diam. **Peridial hyphae:** hyaline, verticillately branched; cells echinulate, slightly constricted at septa. **Appendages:** straight, tapered hyphae, to 480um long, 2.4um wide at base, 1.2um at tip; elongate, smooth-walled helices. **Anamorph:** Microconidia borne singly, clavate, 2 x 3-8um. Macroconidia numerous, ellipsoidal, walls to 5um thick, echinulate, 10-15 x 31-75um. **In culture:** [UAMH 2937]. CER 14/25°C tan to yellow, granular, radiately grooved, margin pale violet; reverse uncolored. DSA 42/25°C bright rose-pink, localized, feathery appressed growth; reverse bright rose. PYE 42/25°C tan to violet, suede-like to slightly granular; reverse dark violet.

Notes: This widely distributed species has been isolated from soil, and hair of wild animals.

Material examined: UAMH 746/sheep wool/Alberta, coll. Carmichael (1960); 2937 (=ATCC 14387, +SAC from type) (1968); 3282/rat/India, Ajello CDC B-359 (1969); 3283/cotton rat/Georgia, Ajello CDC X-36 (1969); 3284/rat/Australia, Ajello CDC X-256 (1969); 3285/soil/Poland, Ajello CDC X-301 (1969).

Nannizzia cookiella De Clerq, 1983 Mycotaxon 18:24-26 FIG 1-4.

Type material: HOLOTYPE (*cultura desiccata*) **CBS** (SA8mt- x SA9mt+) (soil, Ivory Coast).

Anamorph name: *Microsporum* state of *Nannizzia cookiella*.

Ascomata: pale buff to yellow, 400-800um. **Ascospores:** 2-3um. **Asci:** 4 x 4-6um. **Peridial hyphae:** pale buff, branched, distal branches curved in "running legs;" cells asperulate, 2-5 x 10-20um. **Appendages:** slender, smooth-walled, approximately 2um wide and 64-400um in length, or helices 10-14um diam. **Anamorph:** Microconidia numerous, pyriform to elongate, 1-2 x 2-8um. Macroconidia numerous, ovoid, mostly 3-septate, thick-walled (2-4um), densely verruculose, 16-18 x 18-34um.

Notes: Colonial morphology is similar to *Microsporum cookei* but macroconidia are smaller. This species does not grow at 37°C and is apparently nonpathogenic.

Material examined: None. Description taken from the original.

Nannizzia corniculata Takashio and C. DeVroey, 1982 Mycotaxon 14:383-389 FIG 1-6.

Type material: HOLOTYPE (*cultura desiccata*) **CBS** (SA3 x SA26) (soil, Somalia).

Anamorph name: *Microsporum boullardii* Dominik and Majchrowicj, 1966.

Ascomata: pale buff to yellow-buff, 370-870um diam. **Ascospores:** 1.7 x 2.7um. **Asci:** 4-5 x 5-5.5um. **Peridial hyphae:** pale buff, verticillately branched (up to 4x) at distal ends. **Appendages:** straight or curved, elongate, slender, smooth-walled, 2-2.5 up to 11 times coiled, coils 10-20*u*m wide; distal branches 1-5 celled, curved or coiled; ossiform cells 3-7 x 10-28*u*m, moderately thick-walled, densely asperulate, termini thickened, except terminal cells which taper slightly to a blunt end. **Anamorph:** Microconidia 1.7-2.9 x 3.3-8.3*u*m. Macroconidia 1-8-septate, (usually 4-septate), 4.6-9 x 23-54*u*m.

Notes: Known only from the type isolations.

Material examined: None. Description taken from the original.

Nannizzia fulva Stockdale, 1964 Sabouraudia **3**:120 FIG 1ef, PL 1ef.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** 100665 (soil, Hungary).

≡*Nannizzia gypsea* var. *fulva* (Stockdale) Apinis, 1964.

Anamorph name: *Microsporum fulvum* Uriburu, 1909. (see Rebell and Taplin (1970))

Ascomata: pale buff to yellow-buff, 350-1250*u*m diam. **Ascospores:** 1.5-2 x 2.8-3.5*u*m. **Asci:** 5-7*u*m. **Peridial hyphae:** pale buff, verticillately branched with up to 5 branches curving in to main axis; cells with 1-3 ±symmetrical constrictions, up to 7-8*u*m diam., densely asperulate. **Appendages:** arising terminally and laterally from cells of peridial hyphae: straight, slender, smooth-walled, septate hyphae, up to 250*u*m long, 3-4.5*u*m wide at base tapering to 1.5-2*u*m wide at tip; slender, smooth-walled, septate, helical hyphae, ±branched, loosely to tightly coiled. **Anamorph:** Microconidia clavate, smooth-walled or slightly roughened, unicellular or sometimes 1-septate, sessile or on short sterigmata, 1.7-3.3 x 3.3-8.3*u*m. Macroconidia cylindrical, slightly tapering towards each end and with a rounded apex, or clavate, occasionally ellipsoid or fusiform, up to 5-septate, moderately thick-walled thick (0.8-1.1*u*m) and verrucose, 7.5-12 x 25-58*u*m. **In culture:** [UAMH 1480]. CER 21/25°C creamy buff, slightly granular to felty; reverse cream-yellow. DSA 14/25°C white, sparse and very localized; reverse uncolored. PYE 35/25°C tawny to rosy buff, surface irregular and chamois like; reverse cream-yellow.

Notes: This species is world-wide in distribution and is occasionally pathogenic.

Material examined: UAMH 1480 -SAC from CMI 86180 (Szathmary) (1962).

Nannizzia grubyia Georg, Ajello, Friedman and Brinkman, 1962 Sabouraudia 1:194 PL 2 and 3.

Type material: HOLOTYPE (*cultura desiccata*) **ATCC** 14422(+) x 14423(-) (SACs from fertile cross between isolates from a dog and a human).

Anamorph name: *Microsporum vanbreuseghmii* Georg *et al.*, 1962.

Ascomata: white at first, buff at maturity, 150-600*u*m diam. **Ascospores:** 2.4 x 3*u*m. **Asci:** 4.8-6*u*m. **Peridial hyphae:** hyaline, uncinately and dichotomously branched; cells thick-walled, moderately constricted in centre, 4-5*u*m diam.

(occasionally 7.5-10*u*m diam.) densely echinulate. **Appendages:** short, smooth-walled, loosely coiled hyphae with 2-3 gyres and elongate, smooth-walled septate hyphae (1.5-3*u*m diam.) with up to 50 gyres. **Anamorph:** Microconidia numerous, single and lateral, pyriform to obovoid, 4 x 9*u*m. Macroconidia numerous, stalked, lateral or terminal, cylindro-fusiform with thick (2-2.5*u*m), echinulate walls, mostly 7-10 septate, 10-11 x 59-62*u*m. **In culture:** [UAMH 1465]. CER 21/25°C rosy pink, granular; reverse pale yellow with slight pink tinge. PYE 14/25°C bright rosy pink, felt like; reverse pale yellow.

Notes: This species is cosmopolitan and is not a significant pathogen although it has been observed to cause disease in opossums, squirrels and dogs. It is pathogenic to guinea pigs under experimental conditions according to Domsch, Gams and Anderson (1980).

Material examined: UAMH 1465 from CDC Georg X470 (1965).

Nannizzia gypsea (Nannizzi) Stockdale, 1963 Sabouraudia 3:119, FIG 1cd, PL 1cd.

Type material: NEOTYPE *(cultura desiccata)* **CMI** 80558 (soil, Australia) *fide* Stockdale *op. cit.*

≡*Gymnoascus gypseus* Nannizzi, 1927. (Basionym).

≡*Nannizzia gypsea* var. *gypsea* (Stockdale) Apinis, 1964.

Anamorph name: *Microsporum gypseum* (Bodin) Guiart and Grigorakis *sensu lato* (see Rebell and Taplin (1970))

Ascomata: pale buff, 300-750(950)*u*m diam. **Ascospores:** 1.5-2 x 2.5-4*u*m. **Asci:** 5-7*u*m. **Peridial hyphae:** hyaline, up to 4 divergent, verticillate branches, cells densely verrucose, with 1-3 symmetrical constrictions, 4-7 x 8-20*u*m. **Appendages:** terminal; straight, slender, smooth-walled, septate, up to 250*u*m long, 2.5-4*u*m wide at base, tapering to 1.5-2 at tip; helices, 2.5-3.5*u*m wide at base, tapering to 1.5-2*u*m, loosely to tightly coiled. **Anamorph:** Microconidia clavate, smooth-walled or slightly roughened, 1.7-3.3 x 3.5-8.5*u*m. Hyaline chlamydospores rare. Macroconidia moderately thick-walled (0.8-1.2*u*m), verrucose, ellipsoid to fusiform, up to 5-septate, 8.5-15 x 25-58*u*m often with a "whip-like" appendage, to 1-1.5 x 30*u*m, on repeatedly branched conidiophores. **In culture:** [UAMH 1485]. CER 21/25°C tawny buff, granular; reverse uncolored. PYE 35/25°C tawny buff with patches of fine white overgrowth; reverse yellowish brown, pink to rosy vinaceous at centre.

Notes: The anamorph is frequently recovered from soil, hair and skin of monkeys, dogs, rats, mice and other small mammals. Ajello (1953) provides a detailed discussion of the anamorph, and Weitzman (1964) a genetic study of pleomorphism.

Material examined: UAMH 1485 +SAC from CMI 86175, Dawson (1962); 1616/soil/Oklahoma, Keeping #3 (1963); 3342/child/Michigan, Hand, CDC X-11 (1970); 3344/norway rat/Georgia, Menges 2655 =CDC X-42 (1970); 3345/dog/Georgia, Menges NC 13 =CDC X-41 (1970); 3346/field mouse/Georgia, Menges 2600 =CDC X-42 (1970); 3350/eye lesion/South Carolina, Georg CDC X-531 (1970).

Nannizzia incurvata Stockdale, 1961 Sabouraudia 1:46-47 PL 1a-e.

Figs 5a,b,c

Type material: HOLOTYPE (*cultura desiccata*) **CMI** 82777 (human skin lesions, England).

≡*Nannizzia gypsea* var. *incurvata* (Stockdale) Apinis, 1964.

Anamorph name: *Microsporum gypseum* (Bodin) Guiart and Grigorakis *sensu lato*. (see Rebell and Taplin (1970))

Ascomata: white becoming yellowish buff, 350-500*u*m diam. **Ascospores:** 1.5-2 x 2.5-3.6*u*m. **Asci:** 5-7*u*m. **Peridial hyphae:** up to 5, often convergent, verticillate branches, curving toward main axis; cells 7-8*u*m diam. and 10-24*u*m long with ±symmetrical constrictions, densely asperulate. **Appendages:** elongate, slender, smooth-walled, septate, occasionally branched, up to 300*u*m long and 3-4.5*u*m wide at base tapering to 1.5-2*u*m, straight or with up to 30 coils. **Anamorph:** Microconidia clavate, smooth-walled or slightly roughened, 1.7-3.3 x 3.5-8.5*u*m. Hyaline chlamydospores rare. Macroconidia moderately thick-walled (0.8-1.2*u*m), verrucose, ellipsoid to fusiform, up to 5-septate, 8.5-15 x 25-58*u*m, on repeatedly branched conidiophores. **In culture:** [UAMH 1484]. CER 14/25°C pale yellowish white, radiate; reverse pale yellow. PYE 14/25°C yellowish buff, felty, concentrically grooved; reverse orange-brown to tan.

Notes: Kwon-Chung (1969) gives a developmental study of this species. Varsavsky *et al.* (1966) report a mutant with smooth-walled conidia. Weitzman (1964) provides a genetic study of pleomorphism. The species is recorded from Germany, Czechoslovakia, Netherlands and Iran, from birds and field mice (Domsch, Gams and Anderson (1980)).

Material examined: UAMH 1484 =CMI 82777 from C. H. Whittle, (type as cited) (1962).

Nannizzia obtusa Dawson and Gentles, 1961 Sabouraudia 1:56-57 PL 4a-e.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** (pig, Kenya and human, Cuba).

Anamorph name: *Microsporum nanum* Fuentes, 1956. (see Rebell and Taplin (1970))

Ascomata: pale buff, 250-450*u*m diam. **Ascospores:** 1.2-2 x 2.7-3.2*u*m. **Asci:** 5-6 x 5.5-6.5*u*m. **Peridial hyphae:** pale yellow, branching dichotomous or occasionally verticillate with angle obtuse; cells 4-7 x 8-20*u*m with 1 or 2 slight constrictions, echinulate. **Appendages:** lateral or terminal, septate, smooth-walled, tightly coiled; and/or terminal, elongate, slender, septate, to 450*u*m long. **Anamorph:** Microconidia sessile, clavate to cylindrical, mostly 2 x 5*u*m. Macroconidia numerous, thick-walled, finely verrucose, ovoid or ellipsoidal (rarely spherical), 1-2 septate, 5-7 x 17-18*u*m (rarely 24*u*m long and more than 3-celled). **In culture:** [UAMH 3498]. CER 21/25°C ochre to yellow, granular with a broad hyaline margin; reverse yellowish tan. DSA 42/25°C yellowish tan, sparse growth; reverse tan to yellow. PYE 21/25°C ochre yellow with cream overgrowth, cottony with irregular hummocks; reverse reddish brown at the centre, margin yellowish tan.

Notes: This species is a cosmopolitan pathogen of pigs. It occasionally causes disease in man.

Material examined: UAMH 592/human skin lesion/Alberta, coll. Carmichael (1957); 1128/human/Mexico, Georg CDC X-427 (1961); 1129/human/Louisiana, Georg CDC X-310 (1961); 1130/human/Indiana, Georg X-313 (1961); 3498/human/Alberta, coll. Carmichael (1972); 4133/pig/Alberta, Vet. Lab. Lethbridge 911 (1978).

Nannizzia ossicola (Rostrup) Apinis, 1964 Mycol. Pap. **96**:33-34.

Type material: HOLOTYPE (bones, feathers) **Royal Veterinary and Agricultural College, Copenhagen** (dead seabirds, Britain).

≡*Gymnoascus ossicola* Rostrup, Bot. Tidssk. 21:45, 1897 (Basionym).

≡*Rollandina ossicola* (Rostrup) Apinis, Trans. Brit. mycol. Soc. **55**:500 1970.

Anamorph name: *Chrysosporium* ? (similar to *Chrysosporium tropicum* Carmichael, *fide* Apinis *op. cit.*).

Ascomata: white (grey or yellowish with age), 2-5mm diam. appearing smooth and firm at maturity. **Ascospores:** hyaline, very slightly roughened, 1-1.5 x 2-3.5*u*m. **Asci:** 6-8*u*m. **Peridial hyphae:** hyaline, loosely interwoven branched and anastomosed hyphae, 2-5*u*m, septate, delicately asperulate. **Appendages:** numerous, relatively short, hyaline, septate, branched, delicately roughened straight, bent or coiled, rounded at tip. **Anamorph:** conidia subglobose, angular, ovoid or pyriform, spinulose, 2.5-5 x 5-9*u*m.

Notes: No cultures are available. Material on bones and feathers of dead seabirds at Skegness Coast, Great Britain and at Royal Veterinary and Agricultural College, Copenhagen, 1954 was examined by Apinis and checked against original description. He later moved the species to *Rollandina* (a rejected name). This species is not well accommodated in *Nannizzia* due to the size and texture of the ascomata, and the nature of the anamorph. The roughened ascospores might indicate that this is a species of *Nannizziopsis* of the Onygenaceae. Further clarification of the taxon requires fresh material.

Nannizzia otae Hasegawa and Usui, 1974 Jap. J. Vet. Sci. 36:447-449 FIG 1-6.

Type material: HOLOTYPE (*cultura desiccata*) **VMUT** -1 74037(+) X 74039(-) (cat, Japan).

Anamorph name: *Microsporum canis* Bodin, 1902. (see Rebell and Taplin (1970))

Ascomata: white to pale buff, 280-700*u*m diam. excl. appendages. **Ascospores:** 2-2.5 x 2.5-3.8*u*m. **Asci:** 5-7*u*m. **Peridial hyphae:** hyaline, branching dichotomous or verticillate, tips often blunt and curved toward or away from the main axis; cells constricted at septa, echinulate. **Appendages:** long, straight, slender, smooth-walled hyphae up to 150*u*m long, helical. **Anamorph:** Microconidia clavate, 2.5-3.5 x 4-7*u*m. Macroconidia spindle-shaped, thick-walled (to 4*u*m), heavily roughened with puncta and warts especially at distal end, 15-20 x 60-125*u*m, up to 14-septate, septa frequently diagonal. **In culture:** [UAMH 3754]. CER 14/25°C centre yellow, felty, radiate striate, margin broad, white, striate; reverse yellow. DSA 42/25°C cream tan, localized knots of mycelium on hairs; reverse pale yellow. PYE 7/25°C bright yellowish tan, floccose, pin-wheel pattern with radiate streaks of darker brown; reverse reddish tan, at margin bright tan yellow.

Notes: This common pathogen of kittens, puppies and children is occasionally isolated from soil (Emmons *et al.*).

Material examined: UAMH 3754 -SAC (=VUT 74039, mating type strain as cited), Hasegawa (1975).

Nannizzia persicolor Stockdale, 1967 Sabouraudia 5:357-358 FIG 1ab.

Type material: HOLOTYPE *(cultura desiccata)* **CMI** 126886 (soil and human hair).

=*Nannizzia quinckeana* Balabanov and Schick, 1970 *fide* Collinge and Stockdale, 1973 and Padhye and Ajello, 1974.

Anamorph name: *Microsporum persicolor* (Sabouraud) Guiart and Grigorakis, 1928. (see Rebell and Taplin (1970))

Ascomata: buff, 350-900*u*m diam. **Ascospores:** 1.6-2.1 x 2.5-3.3*u*m. **Asci:** 4.5-6 x 5-7*u*m. **Peridial hyphae:** pale buff, branched; cells symmetrical with one central constriction, 3.5-7.5 x 5.5-27.5*u*m, verruculose. **Appendages:** numerous, branched helical coils. **Anamorph:** Microconidia pyriform to subglobose. Macroconidia minutely echinulate, rare, clavate to fusiform, 3-5 septa, 6-8 x 30-40*u*m. **In culture:** [UAMH 2939]. CER 14/25°C yellow-tan, granular; reverse white to pale beige. DSA 42/25°C yellowish beige, granular; reverse tan. PYE 22/25°C cream-tan, suede to slightly granular; reverse tan-brown.

Notes: This widely distributed species is a mild pathogen of small rodents (bank voles and field voles) and rarely infects humans (Padhye *et al.*, 1973). It resembles *Trichophyton mentagrophytes* and is often confused with it. Colonies are frequently shades of pink and buff.

Material examined: UAMH 2557/fork-tailed kite/Australia, Rees H. 427 (1965); 2612/soil/South Africa, SAIMR, 192 (1966); 2841/chicken feathers/India, Padhye (1967); 2939 -SAC from CMI 117064 from type (1968); 3509/human foot/Maryland, Ajello, CDC 40-72-018500 (1972); 3511/human/Quebec, Blank #1 (1972); 3514/human/Pennsylvania,

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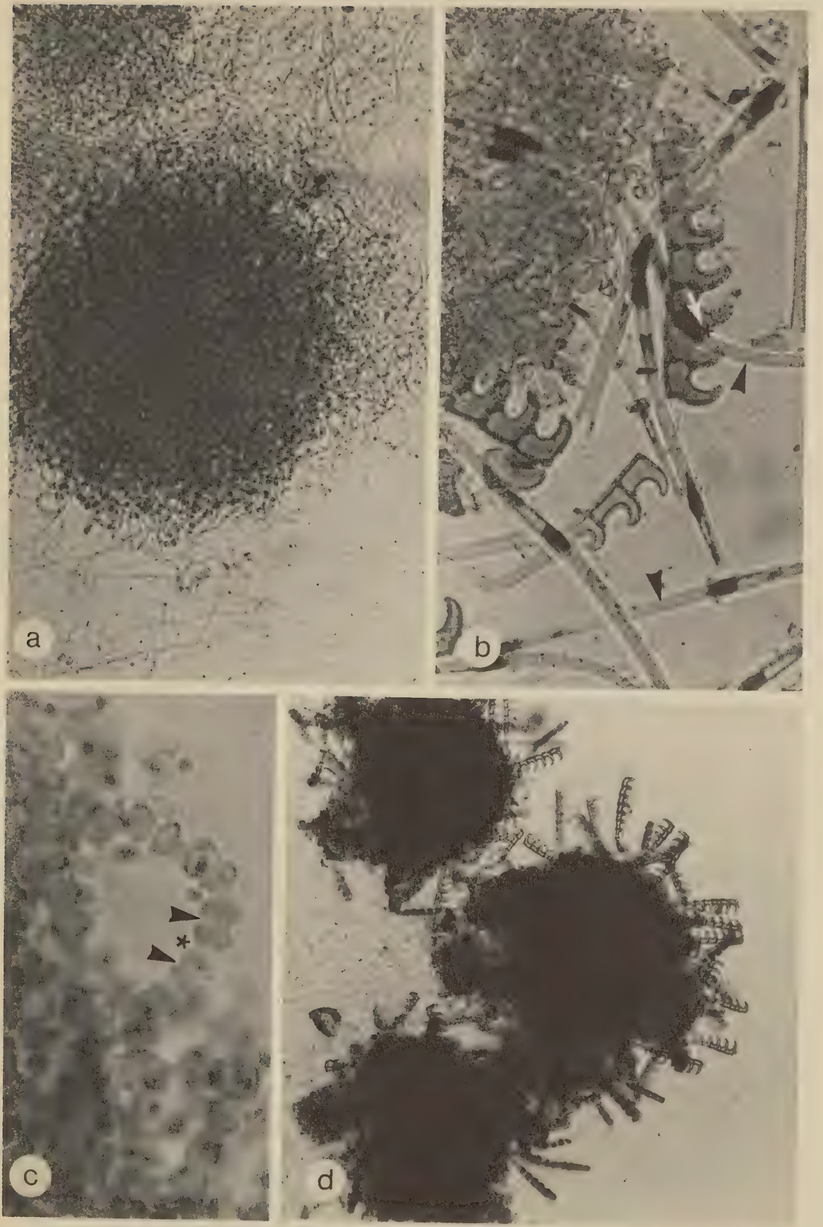
Fig. 6. Representative Arthrodermataceae. a. *Arthroderma curreyi* (UAMH 4768). Ascoma from dung sample. Ossiform cells composing the reticuloperidium discernible at periphery. X160. b. *Ctenomyces serratus* (FH Thaxter 173). Arrows indicate feather pennulae. The significance of the appendage morphology indicated at asterisk. X270. c. Ossiform cells of the peridial hyphae of *Arthroderma curreyi* (UAMH 4768). Arrows indicate septa; asterisk indicates central constriction. X1800. d. *Ctenomyces serratus* (FH Thaxter 166). Three individual ascomata showing morphology and disposition of ctenoid appendages on the external hyphae. X75.


a
b
c
*
d

Blank #12 (1972); 4023/vole/Quebec, Kapica, McGill Univ. (1977); 4024/human/Quebec, Kapica, McGill Univ. (1977); 4370/human/Edmonton, Rodvang (1981).

Nannizzia racemosa Rush-Munroe, Smith and Borelli, 1970 Mycologia **62**:858 FIG 1-5.

Type material: HOLOTYPE *(cultura desiccata)* **CMI 128984** (forest rat, Venezuela).

Anamorph name: *Microsporum racemosum* Borelli, 1965.

Ascomata: pale buff, 300-700*u*m diam. **Ascospores:** 1.2-1.5 x 2.5-3*u*m. **Asci:** 4.4-5.5*u*m. **Peridial hyphae:** hyaline, verticillately and dichotomously branched, (up to 4 branches per cell apex), cells, with up to 3 ±symmetrical constrictions, echinulate, to 8*u*m diam. **Appendages:** slender, smooth-walled, septate, 2.3-3*u*m wide at base, tapering to 1.5-2*u*m at the tip and with up to 15 gyres; straight, slender, smooth-walled, 3-4*u*m wide at base tapering to 1.7-2*u*m at tip, to 380*u*m long; delicate, "flagellum-like," smooth-walled, 0.7-0.9*u*m wide and to 200*u*m long. **Anamorph:** Microconidia clavate, stalked and borne in large racemes. Macroconidia spindle-shaped, echinulate, thick-walled, 1-5 septate, 12-15 x 55-65*u*m **In culture:** [UAMH 3367]. CER 14/25°C cream-colored, smooth; reverse violet at margin, centre yellow. DSA 42/25°C white, granular; reverse uncolored. PYE 14/25°C cream-colored, thick, smooth; reverse yellow with violet patches.

Notes: This species is probably cosmopolitan (Howard, 1983). It is pathogenic under experimental conditions and has been reported from forest rat, Venezuela; soil, Brazil; squirrel and badger soil, Europe (Rush-Munroe *et al., op. cit.*)

Material examined: UAMH 3367 -SAC from Rush-Munroe, New Zealand.

GYMNOASCACEAE

Gymnoascaceae Baranetzky, 1872

Type genus: *Gymnoascus* Baranetzky, 1872.

Ascomata: white, yellow, red, green or brown, never darkly pigmented; ±globose when discrete; ascomata often confluent or barely differentiated, in this case, consisting of clusters of ascospores surrounded by vegetative mycelium; arising from one or more gametangial pairs; diameter of individual ascomata generally <1000*u*m. **Ascospores:** hyaline, pale or brightly colored - yellow, orange or red; generally oblate (never globose), thick-walled, unornamented, or with one or two equatorial rims, or with a shallow equatorial groove; polar thickenings present or absent; walls smooth or undulate (lumpy) in some taxa, never pitted; up to 9*u*m diam. **Asci:** globose to ovoid, to 15*u*m diam. **Peridial hyphae:** variable in three categories; hyphae undifferentiated from vegetative hyphae and/or slightly irregular, resembling, in total, a mass of cob-webs and forming a telaperidium; or disjointed, irregular, thick-walled elements lacking any distinct organization and forming an incompositoperidium; or thick-walled, regular elements organized to resemble a cage-like structure or reticuloperidium; never forming a membranous peridium. **Appendages:** absent or well-differentiated and of elongate, ±branched, thick-walled hyphae with characteristic shape and/or branching pattern. **Sexuality:** homothallic. **Anamorph:** absent or rare; arthroconidial.

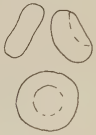
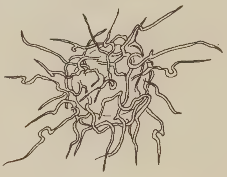
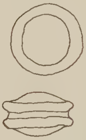
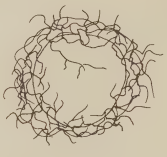
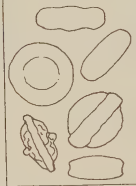
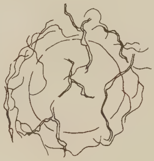
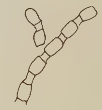
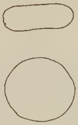
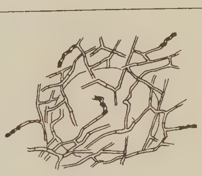
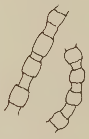
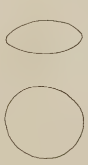
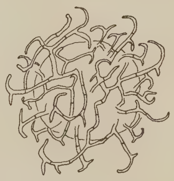
Notes: The genera included in this family (see Table 11) represent an artificial assemblage which, by their peridial characteristics and habitat, have been traditionally classified with the keratinolytic Arthrodermataceae and Onygenaceae, and the cellulolytic Myxotrichaceae. Many Gymnoascaceae also share the same habitats as these families. The Gymnoascaceae do not display any marked substrate preferences although some may be mildly cellulolytic.

The well-developed reticuloperidium of *Gymnoascus* is superficially similar to the reticuloperidium of many Onygenaceae (*Auxarthron* in particular), as well as *Ctenomyces* of the Arthrodermataceae, and many Myxotrichaceae. The grouping of taxa with these mesh-like peridia was a logical approach to the development of the concept of the Gymnoascaceae. Closer examination of ascospore morphology and substrate preferences indicates that groupings made purely on the basis of this one character yield an unsatisfactory and artificial system. Convergence of morphological characteristics has several precedents in the fungi (e.g. gasteromycetation and cyphellization in basidiomycetes) (Singer, 1975), and in the vascular plants (e.g. succulence and leaf-spine modifications in some Cactaceae and Euphorbiaceae). In fact, examples could be drawn from nearly all major groups of organisms.

I strongly suspect that the affinities of some of the taxa here considered in the Gymnoascaceae are closer to the Eurotiales than to the Onygenales. Some species do not have an anamorph and, since the primary distinction between the two orders is based conidium ontogeny, satisfactory disposition of these species is difficult. The genus *Talaromyces* of the Eurotiales produces a distinctive telaperidium and this genus (among others of the order) is easily confused with *Arachniotus* and *Gymnascella*. None of the Eurotiales produces a reticuloperidium, similar to that of *Gymnoascus*, although this order exhibits almost every other conceivable peridium variation (from lacking in *Byssochlamys*, to complex and subtended by a stipe in *Penicilliopsis*). I suspect that the "missing" peridial variation (i.e. reticuloperidium) in the Eurotiales might eventually be determined to be represented by *Gymnoascus*. In this case the Eurotiales and the Onygenales would prove a striking example of parallel evolution, with the reticuloperidium of *Gymnoascus* mirrored by the similar reticuloperidium of *Auxarthron* (See Table 4). Further, the incompositoperidium of *Gymnascella devroeyi* may also be eurotialean.

None of the Gymnoascaceae (as they are defined here) have

TABLE 11 GENERA OF GYMNOASCACEAE

Genus	Ascospores	Peridia and Appendages	Anamorphs
Acitheca			?
Arachniotus			—
Gymnascella			
Gymnoascoideus			
Gymnoascus			—

been implicated as *bona fide* pathogens of humans or other animals, although they are frequently isolated from animal materials (dung, rejectamenda, litter and soil associated with animals), or from the animals themselves (lungs, skin scrapings, hair etc.) They are also isolated, but less often, from agricultural soils.

The frequent association of these taxa with animals might be due to an inability to compete with other fungi in other habitats. Many are slow growing even on artificial media; and on natural substrata in culture, they are usually among the later species to develop. Ecological studies of the group are limited to brief records in substrate or habitat surveys (e.g. Dunn and Baker, 1983). A major impediment to ecological studies has been a lack of a satisfactory taxonomic treatment. This deficiency may explain why many ecological studies of probable sources of Gymnoascaceae (e.g: owl pellets, Philips and Dindal, 1982; various types of herbivore dung, Angel and Wicklow, 1983) surprisingly lack records of these taxa. Data from ecological and ultrastructural studies may give the information required to determine natural relationships among these taxa and relationships to representatives of other orders.

ACITHECA Currah, gen. nov.

Typus: Acitheca purpurea Thaxter ex Currah *sp. nov.*

Ascoma rufula fulva, globosa, 200-750um, appendiculi inclusi. Ascosporae purpurae aut violae, oblatae, levae, <6um diam., octospori. Asci globosi aut ovati, 8-11um diam. Hyphae peridii purpurae, crasso-parietales, asperatae, sinuosae et raro ramosae, intexerate facere theca reticulata. Appendicula sinuosa, aliquando ramosae, elongatae, acutae, modo aci. Homothallicus aut heterothallicus ignotus. Stat. conid. ignotus.

ACITHECA Currah, gen. nov.

(*acus* - needle; *theca* - coat).

Type species: *Acitheca purpurea* Thaxter ex Currah *sp. nov.*

Ascomata: reddish brown, globose, 200-750*u*m diam. incl. appendages. **Ascospores:** pale purple or violet, oblate, smooth, thick-walled, 3-3.3 x 4.5-5.2*u*m. **Asci:** globose to ovoid, 8-10.4*u*m diam. **Peridial hyphae:** purple, thick-walled, slightly roughened, sinuate, branches rare, interwoven to form a reticuloperidium. **Appendages:** sinuate, occasionally branched, elongate, pointed, "needle-like." **Sexuality:** unknown. **Anamorph:** unknown.

Notes: The well-developed reticuloperidium and smooth oblate ascospores of this taxon make it similar to *Gymnoascus*. The sinuate and sparingly septate peridial hyphae; long, tapering, aseptate, needle-like appendages; and relative lack of branching, distinguish *Acitheca* from *Gymnoascus*. In *Gymnoascus* the reticuloperidium is composed of richly branched and septate, thick-walled hyphae, and the appendages are relatively blunt. In addition, *Gymnoascus* is predominantly a coprophile and I have no records of its ever having been isolated from tree bark.

Superficially, *Acitheca* resembles *Myxotrichum cancellatum*, particularly since they both have long, needle-like appendages. However, pigmentation and most importantly, ascospore morphology are quite different. *Myxotrichum cancellatum* has dark brown peridial hyphae and long striate, pale yellow, fusoid ascospores.

The genus *Acitheca* contains only one species.

Acitheca purpurea Thaxter ex Currah *sp. nov.*

Typus ab cortice Robini, Massachusetts.

Ascoma rufula fulva, globosa, 200-750um diam. appendiculi inclusi. Ascosporae purpurae aut violae, oblatae, levae, crasso-parietales, 3-3.3 x 4.5-5.2um. Asci globosi aut ovati, 8-11um diam., octospori. Hyphae peridii purpurae, crasso-parietales, cum foveis minutis, sinuosa, raro ramosae. Appendicula 2.7-3.3um diam. ad origem, sinuosa, aliquando ramosae, elongatae acutae, 0.2um diam. modo promissi aci, 80-210um in longitudinem.

Acitheca purpurea Thaxter ex Currah *sp. nov.*
Figs 7a,b 32a,b,c

Type material: HOLOTYPE (bark fragments) **FH** Thaxter 508 (*Robinia* bark, Massachusetts).

"*Gymnoascus purpureus*" Thaxter *ineditatio.*

Ascomata: reddish brown, globose, 200-750*u*m diam. including appendages. **Ascospores:** pale purple or violet, oblate, smooth, thick-walled, 3-3.3 x 4.5-5.2*u*m. **Asci:** globose to ovoid, 8-10.4*u*m diam. **Peridial hyphae:** purple, aseptate, thick-walled with small pits, 2.7-3.3*u*m diam., sinuate, branches rare. **Appendages:** 2.7-3.3*u*m diam. at base, sinuate, irregular, occasionally branched, evenly tapering to an acute point 0.2*u*m diam., 80-210*u*m in length. **Anamorph:** unknown. **In culture:** unknown.

Notes: Known only from Thaxter's type collection which consists of flakes of bark covered, for the most part, with dense patches of purple ascomata.

Material examined: FH Thaxter 508 (type as cited).

ARACHNIOTUS Schroeter, 1893

KryptogamenFlora von Schlesiens 3:210.

Type species: *Arachniotus ruber* (Van Tieghem) Schroeter *op. cit.* (LECTOTYPE *fide* Von Arx, 1970)

Ascomata: orange to red, discrete, spherical, 20-300*u*m, sometimes confluent. **Ascospores:** orange to yellow, smooth, "pulley-wheel" shaped with an equatorial groove bordered by distinct ridges, poles thickened, <7*u*m diam. max. **Asci:** hyaline, ovoid, 10*u*m diam. approx. **Peridial hyphae:** present or absent, often sparse, smooth, thin-walled, septate, constricted at septa, sometimes irregular in diam. 1-3.3*u*m wide. **Anamorph:** lacking.

Notes: Schroeter (1893) first described *Arachniotus* to include *Gymnoascus candidus* and *Gymnoascus aureus* Eidam, 1886, and *Gymnoascus ruber* van Tieghem, 1877. He considered the genus a member of Eidam's 'Gymnoasceen' and used the nature of the peridium as a key character in distinguishing it from *Gymnoascus*, *Myxotrichum* and *Ctenomyces*. Hyaline, red or yellow ascospores distinguished *Arachniotus* from violet or brown-spored *Amauroascus*. Clements and Shear (1931) subsequently listed the type of *Arachniotus* as *Arachniotus candidus*. Unfortunately, no holotype material of this species has been found, although numerous collections are cited in Schroeter's description, including Eidam's original material on cooked rice from Breslau, Germany. In later treatments of the genus (Kuehn, 1958; Orr, Ghosh and Roy, 1977), *Arachniotus candidus* was again listed as the type of the genus. Von Arx (1970), however, listed *Arachniotus ruber* as the type of the genus, since it could be readily recognized using Eidam's original description, and, since a neotype collection had been made for the species. He justly felt that *Arachniotus candidus* was not recognizable from the description which could apply to any number of genera with poorly differentiated, hyaline peridial hyphae. Arachniotus candidus is considered a *nomen dubium* unless a type can be located.

Arachniotus ruber (Van Tieghem) Schroeter, 1893
KryptogamenFlora von Schlesiens **3**:211.
Figs 8a,b,c 9a,b,c 26e
Type material: NEOTYPE (*cultura desiccata*) **NY** O-3314. (soil, Britain). (*fide* Orr, Ghosh and Roy, 1977).
≡*Gymnoascus ruber* Van Tieghem, Bull. Soc. Bot. Fr. **24**:159, 1887 (Basionym).
≡*Pseudoarachniotus ruber* (Van Tieghem) Orr, Ghosh and Roy, Mycologia **69**:153, 1977.
=*Pseudoarachniotus trochleosporus* Kuehn and Orr, Mycologia **64**:58, 1972.

Ascomata: orange to red, discrete or undifferentiated, spherical, 20-300*u*m diam., sometimes confluent (on natural materials ascomata may develop to a diam. of 1000*u*m). **Ascospores:** orange to yellow, smooth, "pulley-wheel" shaped with an equatorial groove bordered by distinct ridges, poles thickened, 2.8-4.4 x 4-6.6*u*m. **Asci:** hyaline, ovoid, 7-10 x 10-13*u*m. **Peridial hyphae:** present or absent, often sparse, smooth, thin-walled, septate, constricted at septa, sometimes irregular in width, 1-3.3*u*m. **Anamorph:** Van Tieghem's original description noted a *Verticillium*-like anamorph but this was probably a contaminant. Kuehn & Orr (1964) noted production of hyaline arthroconidia, but these were never observed in the present study. **In culture:** [UAMH 3543, 4763]. **PDA 25°C** At first pale pink to pinkish orange, slightly granular; reverse becoming pale yellowish orange. After 30 days obverse is deep orange to rusty orange or brown; reverse deep orange to chestnut brown. On OAT, growth is pale yellow and scant. [UAMH 4763]. CER 42/25°C pale rose, to white or pale tan, fuzzy becoming granular; reverse orange-red. DSA 42/25°C white to off-white, scant; reverse uncolored. PYE 42/25°C thick, dense, white to pale tan; reverse tan.

Notes: This beautiful and distinctive species is rarely isolated. Domsch, Gams and Anderson (1980) refer to its isolation from soil, plant litter, rhizosphere of wheat and hazel nut, as well as freshwater streams and various types of dung. My only isolation of this species came from coyote dung incubated at 5°C where it grew abundantly and fruited in quantity. At higher temperatures this species was not able to compete with other coprophilous fungi. Low temperature primary isolation procedures (which are more time consuming) might prove that this species is more widespread and more common than the literature implies.

Material examined: NY B173/?/? "dried cultures from Orr (1964)"; Massee/dog dung/England, Drawings (1905); O-3158/soil/Holland; O-3366/soil/Germany, Gams C514; Domsch C925/soil/East Germany (dessicated culture); **UAMH** 3543/neotype strain as cited; 4763/dung/Alberta, coll. Currah; as *Gymnoascus* sp.: **FH** ?/dog dung/Argentina (with *Gymnoascus reessii*); **TRTC** Wight 276/soil/Jamaica (natural material); as *Pseudoarachniotus ruber*: **FH** O-3266/soil/East Germany (Domsch 925).

SPECIES EXCLUDED OR REFERRED TO OTHER GENERA

Arachniotus albicans Apinis, Mycol. Pap. **96**:45, 1964
≡*Amauroascus albicans* (Onygenaceae).

Arachniotus aureus (Eidam) Schroeter, KryptogamenFlora von Schlesiens **3**:210, 1893
≡*Amauroascus aureus* (Onygenaceae).

Arachniotus candidus (Eidam) Schroeter, KryptogamenFlora von Schlesiens **3**:210, 1893
≡*nomen dubium*.

Arachniotus flavoluteus Kuehn and Orr, Mycologia **51**:864, 1959
=*Gymnascella dankaliensis*.

Arachniotus glomeratus Muller and Pacha-Aue, Nova Hedwigia **15**:544, 1968 Taf. 76-78.
≡*Arachnotheca glomerata* (Excluded Genera, Chapter 8).

Arachniotus hebridensis Apinis, Mycol. Pap. **96**:41-42, 1964
Type strain in UAMH (3089) is a *Geomyces* sp. Holotype at CMI (sandy pasture soil, Hebrides) was not examined. Udagawa's isolate under this name (from pig dung, Guadalcanal) is keratinolytic and probably a new species of Onygenaceae.

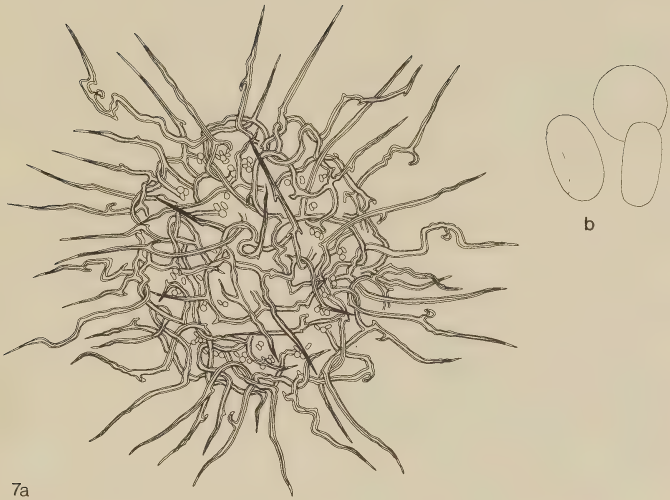
Arachniotus indicus Chattopadhyay and Das Gupta, Trans. Brit. mycol. Soc. **42**:72, 1959
=*Talaromyces flavus* (Klocker) Stolk and Samson var. *flavus* Stolk and Samson, CBS Stud. Mycol. **2**:11, 1972 (Eurotiales).

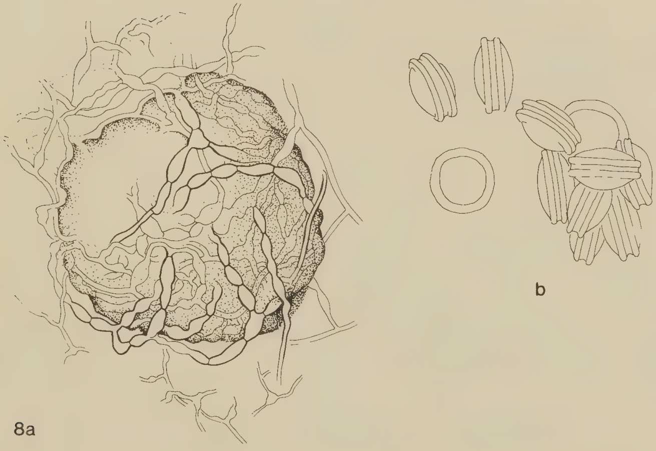
Arachniotus intermedius Apinis, Mycol. Pap. **96**:45, 1964
=*Talaromyces flavus* var. *flavus* Stolk and Samson, CBS Stud. Mycol. **2**:11, 1972 (Eurotiales).

Arachniotus lanatus (Wallroth) Apinis, Mycol. Pap. **96**:39, 1964
(?) Hughes (1968) examined the holotype and reported that it had no ascospores. Apinis (1964) figured ascospores from the holotype. Some hyphae resemble those of *Nannizziopsis vriesii* (Onygenaceae).

Arachniotus lectardii Nicot, Bull. Mycol. Soc. Fr. 85:319, 1969
≡*Eleutherascus lectardii* (Nicot) von Arx, Persoonia **6**:378, 1971 (Pezizales).

Arachniotus niger (Schroeter) Kuehn *et al.*, Mycopathol. et Mycol. Appl. **25**:106, 1965





Figs 7-8. 7. *Acitheca purpurea* (FH, Holotype). a. Globose ascoma (reticuloperidium) of thick-walled, interwoven peridial hyphae. X280. b. Smooth-walled, oblate ascospores. X2585. 8. *Arachniotus ruber* (UAMH 4763). a. A discrete ascoma with a telaperidium. X570. b. Pulley-wheel shaped ascospores. X1830. c. Conglobate ascospores. X1830.

≡*Amauroascus niger* (Onygenaceae).
Arachniotus purpureus Muller and Pacha-Aue, Nova Hedwigia **15**:552, 1968
≡*Talaromyces purpureus* (Muller and Pacha-Aue) Stolk and Samson CBS Stud. Mycol. **2**:57, 1972 (Eurotiales).
Arachniotus reticulatus Kuehn, Mycologia **49**:57, 1957
≡*Amauroascus kuehnii* (Onygenaceae).
Arachniotus striatosporus Barron and Booth, Can. J. Bot. **44**:1060, 1966.
≡*Byssoascus striatosporus* (Myxotrichaceae).
Arachniotus terrestris Raillo, Zentral. Bakt. Inf. **2**, 78:521, 1929 (?, no type material).
Arachniotus trachyspermus Shear, Science **16**:138, 1902 illus in Shear *et al.*, 1931 USDA Tech. Bull. No.258:13
≡*Talaromyces trachyspermus* (Shear) Stolk and Samson, CBS Stud. Mycol. **2**:32, 1972 (Eurotiales).
Arachniotus trisporus Hotson, Mycologia **28**:500, 1936
=*Byssochlamys nivea* Westling, Svensk. Bot. Tidskr. **3**:125, 1909 *fide* Kuehn, Mycologia **49**:55-67, 1957 (Eurotiales).
Arachniotus verrucosus (Eidam) Kuehn *et al.*, Mycopathol. et Mycol. Appl. **25**:103, 1965
=*Amauroascus mutatus* (Onygenaceae).
Arachniotus volatilis-patellis Orr and Kuehn, Mycologia **64**:61, 1972
≡*Amauroascus volatilis-patellis* (Onygenaceae).

GYMNASCELLA Peck, 1885

J. Mycol. 1:57.

Type species: *Gymnascella aurantiaca* Peck *op. cit.*
=*Narasimhella* Thirumalachar and Mathur, 1966.
=*Petalosporus* Ghosh, Orr and Kuehn, 1963.
=*Plunkettomyces* Orr, 1977.
=*Pseudoarachniotus* Kuehn, 1957.
=*Waldemaria* Batista, 1960 *fide* von Arx, 1971.

Ascomata: pale yellow or brightly colored, orange, orange-brown, red, red-orange; ±globose when discrete; often not differentiated into discrete ascomata in agar cultures. **Ascospores:** hyaline, or lightly colored in shades of yellow or orange, oblate, ±polar and/or equatorial thickenings, smooth-walled or somewhat irregular to lumpy, not punctate. **Asci:** hyaline, ovoid to spherical, evanescent or occasionally persistent, 8-spored. **Peridial hyphae:** thin-walled, ±uniform in diameter, similar to vegetative hyphae and forming a telaperidium; or with some irregularly shaped and irregularly thick-walled elements comprising an incompositoperidium. **Appendages:** lacking. **Sexuality:** homothallic. **Anamorph:** uncommon; arthroconidial when present.

Notes: Most species treated here in *Gymnascella* have been regarded at one time or another as species of *Arachniotus*. *Gymnascella* is probably an artificial collection of species. The ascospores are the most important source of information for distinguishing species since accessory structures are variable in morphology and occurrence. Table 12 is a pictorial presentation of ascospore morphology in *Gymnascella* Peck described *Gymnascella aurantiaca* based on a specimen which was deposited at NYS. This material is now insufficient to recognize the species and Von Arx felt it probably represented *Gymnoascus reessii*. An isotype is located at TRTC. Upon examination of this material, I found it to represent the same taxon as *Arachniotus aurantiacus* Kamyschko. Since *Gymnascella* has priority over *Arachniotus*, I have placed all oblate-ascospored species formerly in *Arachniotus*, in *Gymnascella*. *Arachniotus*, typified by *A. ruber*, is reserved for species with a double equatorial band.

Gymnascella afilamentosa (Orr and Kuehn) Currah, comb. nov.

Figs 10a,b,c 28c 29a
Type material: HOLOTYPE **NY** DPG 115 (soil, Utah).
≡*Petalosporus afilamentosus* Orr and Kuehn, Mycologia **64**:62, 1972 FIG 9 and 10. (Basionym).

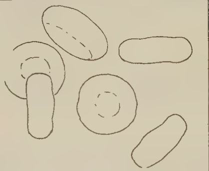
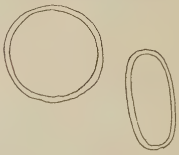
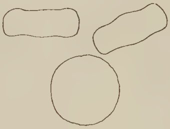
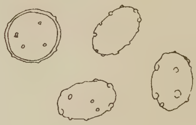
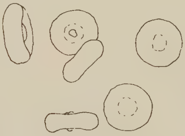
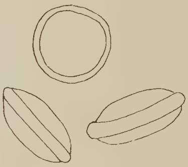
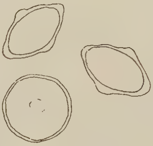
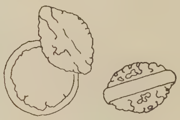
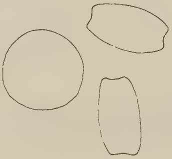
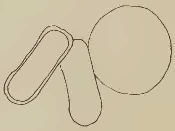
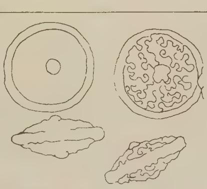
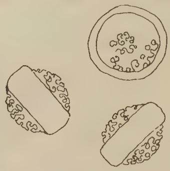
Ascomata: yellow to yellowish brown, rarely discrete, ±globose, to 300*u*m diam. **Ascospores:** pale golden yellow, oblate, smooth, thick-walled, poles slightly depressed with a central thickening, perimeter slightly flattened, 2-3 x 4.5-5*u*m. **Asci:** thin-walled, evanescent, ascospores adhering in characteristic petaloid pattern, to 12*u*m diam. **Anamorph:** lacking. **In culture:** [UAMH 3427]. **PDA 25°C** At first hyaline to faint yellow; reverse pale yellow; obverse soon becoming bright yellow, flocculent and radiately sulcate; At 25 days surface bright yellow with pale buff brown patches developing in central area, thick and felty; reverse pale yellowish brown. Plate covered in 20 days. On OAT mat becomes orange to rusty brown, yellow at the perimeter. CER 28/25°C ochre yellow, granular and irregular; reverse pale yellow. DSA 42/25°C yellow, granular forming concentric zones; reverse cream. PYE 35/25°C yellow, deep felty mat; reverse yellow-brown.

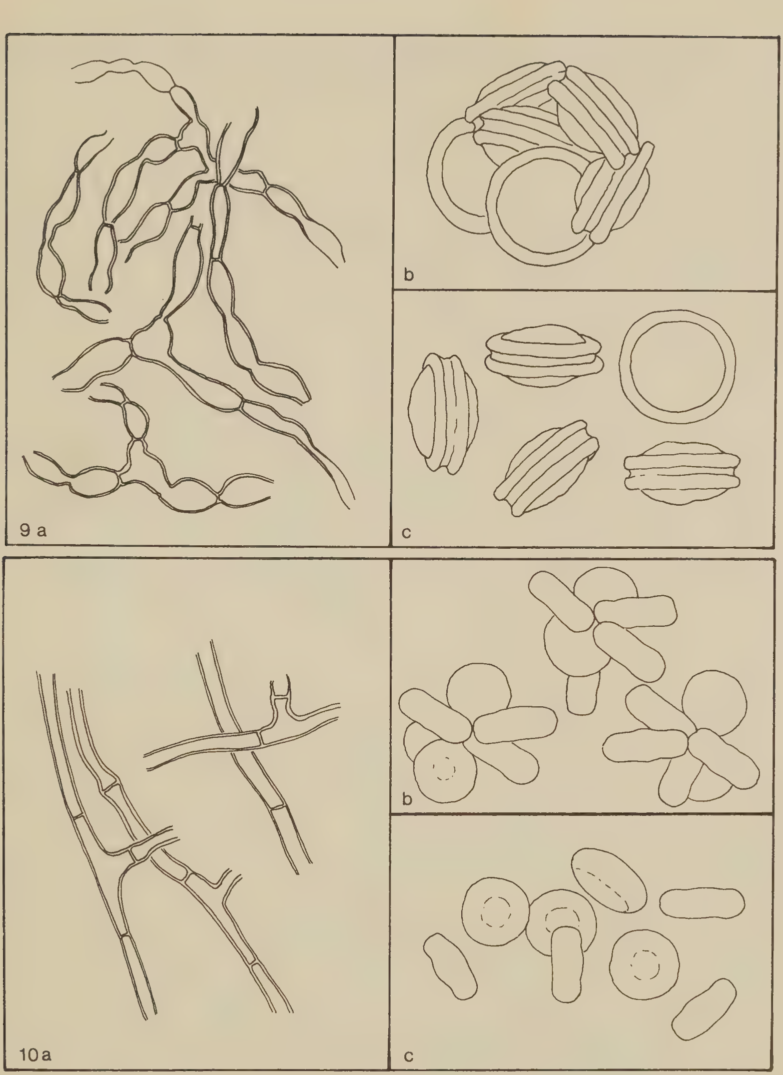
Notes: This species is easily confused with *Gymnascella aurantiaca*. The petaloid arrangement of the ascospores within the ascus in *G. afilamentosa* is the primary character differentiating the two taxa. *G. aurantiaca* ascospores adhere in very compact clusters, and are slightly larger. Cultures of the two species are similar in color but differ in surface texture and growth rate. *G. aurantiaca* is faster growing and has a wispy or less dense mat than *G. afilamentosa*. Reverse coloration also differs between the two species, being yellowish tan in the latter species and yellowish orange in *G. aurantiaca*.

Material examined: NY O-3345/coyote dung/Utah; O-3229/lizard dung/Utah; O-3346/mouse spleen/Utah; O-3533/soil/Utah; O-3427 (O-2601)/soil/Utah (=UAMH 3427, from Orr).

Gymnascella aurantiaca Peck, 1885 J. Mycol. 1:57.
Figs 1f, 11a,b,c 27a,c,d 28a
Type material: HOLOTYPE (natural material) **NYS** Peck (plant debris and bones, New York). (ISOTYPE at **TRTC**).
≡*Gymnoascus aurantiacus* (Peck) Saccardo, Sylloge Fungorum 8:823, 1889 (Basionym).
≡*Myxotrichum aurantiacum* (Peck) Saccardo, Sylloge Fungorum

TABLE 12 ASCOSPORE MORPHOLOGY IN THE SPECIES OF *GYMNASCELLA*

Species	Ascospores	Species	Ascospores
G. afilamentosa		**G. devroeyi**	
G. aurantiaca		**G. hyalinospora**	
G. calcarea		**G. littoralis**	
G. citrina		**G. marginospora**	
G. confluens		**G. nodulosa**	
G. dankaliensis		**G. punctata**	



Figs 9-10. 9. *Arachniotus ruber* (UAMH 3543). a. Thin-walled, ±inflated peridial hyphae. X470. b. Globose ascus with closely packed ascospores. X3290. c. Pulley-wheel shaped ascospores with equatorial grooves bordered by distinctly thickened walls. X3290. 10. *Gymnascella afilamentosa* (NY 0-3345). a. Several slightly thick-walled peridial hyphae. X940. b. Petaloid arrangement of conglobate ascospores. X2255. c. Smooth-walled, oblate ascospores with characteristic wall thickenings based in shallow polar depressions. X2350.

4:319, 1886.
=*Pseudoarachniotus aurantiacus* Kamyschko, Nov. Sist. niz. Rast. **4**:224, 1967.
=*Gymnascella aurantiaca* (Kamyschko) von Arx, Persoonia **6**:373, 1971.
=*Arachniotus verruculosus* Orr and Kuehn, Mycologia **64**:62, 1972.
=*Gymnascella kamyschkoi* Orr, Ghosh and Roy, Mycologia **69**: 137, 1977.

Ascomata: pale yellow to golden yellow, (orange brown), clusters of asci form among hyphae which are mostly undifferentiated from surrounding vegetative mycelium; ascomata may appear as discrete, ±spherical structures, or may not be visibly different from the vegetative mat. **Ascospores:** golden-yellow, oblate, slightly concave; polar surfaces irregular, with or without a distinct boss, or bulge; rim flattened, 2.5-3.5 x 4-6(-7)*u*m, adhering in compact clusters. **Asci:** globose or ellipsoid, 8-12*u*m diam. **Peridial hyphae:** hyaline to pale golden yellow, mostly resembling vegetative hyphae but occasionally with ±thick-walled elements. **Anamorph:** lacking. **In culture:** [UAMH 3529] **PDA 25°C** Mycelium at first hyaline, becoming pale yellow, appressed to slightly granular to tomentose; reverse pale yellow; obverse soon becoming golden yellow, pubescent and remaining smooth; reverse orange yellow to tan yellow. Plate covered in 15 days. On OAT the mature mat is pale yellow, granular, scant with a diffusible yellow pigment. CER 49/25°C Orange, slightly pubescent; reverse pale orange. DSA 42/25°C Yellow brown, granular in a concentric zone, elsewhere pale yellow, scant; reverse concolorous. PYE Cream white, felty; reverse pale yellow.

Notes: *Gymnascella aurantiaca* is a relatively common species and although it has been found in a variety of habitats, it appears to be primarily a coprophilous fungus. The sparse nature of the peridium necessitates careful study of the ascospores to distinguish this species from *Gymnascella afilamentosa* (see above) and *Gymnascella citrina*. The ascospores of the latter species are rhomboidal when viewed on edge and are lemon yellow rather than golden yellow. Besides the type material of *Arachniotus verruculosus* (O-3175, from soil, Utah), I have seen one other collection assignable to this name (TRTC "*Rosellinia schumacheri*" E. Marchal, from dog dung, Brussels). Ascospores are slightly larger and have very slight irregularities in the walls (possibly shallow depressions). Since *Gymnascella aurantiaca* contains some variants with respect to peridial hyphae and color of the ascospores and vegetative mycelium, I prefer to consider this taxon (*Arachniotus verruculosus*) a synonym of *Gymnascella aurantiaca*. *Arachniotus verruculosus* may emerge as a distinct species with the availability of more isolates.

Material examined: NYS (also in TRTC 32167) type material as cited; as *Gymnoascus*: **U** 178821B/owl pellet/Holland; **NY** O-3175/soil/Utah (type of *Arachniotus verruculosus*); **TRTC** 33053/lab contaminant/Ontario; 37072/in culture/Ontario; Cooke 2461/?/U.S; Emmons/bat dung dust/Georgia; **NY** as

Gymnoascus uncinatus O-I-9/soil/Italy; as *Gymnascella kamyschkoi* **NY** O-790/sheep dung/California; O-3005/soil/U.S.S.R.; as *Rosellinia schumacheri* **TRTC** E. Marchal/dog dung/Brussels (?=*Arachniotus verruculosus*; **UAMH** neotype strain 3529 from Von Arx as 603.67 (1972).

Gymnascella calcarea Currah, sp. nov.

Typus: Holotypus Sydow 4031, "fimo capreae, Kewensis," **K.**

Ascocarpi calcarei, ±globosi, minus 1 mm diam., aggregatae. Ascosporae hyalinae, minutae, umbonatus et concavus ad polos. Asci subglobosi vel globosi, octospori, 5-7.5um diam. Hyphae peridii hyalinae, parietes leves, 2-3.5um diam., confertim intertextis. Stat. conid. incognita.

Gymnascella calcarea Currah sp. nov.

Figs 12b,c,d 25a

Type material: HOLOTYPE (on roe dung, Kew) **K.**

Ascomata: chalky white, .5-1mm diam., ±globose, aggregated. **Ascospores:** hyaline, oblate with polar thickenings based in concave depressions. **Asci:** ±globose or ovoid, 5-7.5*um* diam., 8-spored. **Peridial hyphae:** hyaline, slender, smooth-walled, 2-3.5*um* diam., densely interwoven. **Appendages:** lacking. **Anamorph:** unknown.

Notes: The holotype material is mixed with *Oncocladium flavum* as well as other fungi.

Gymnascella citrina (Massee and Salmon) Orr, Ghosh and Roy, 1977 Mycologia **69**:126.

Figs 13a,b,c 26a

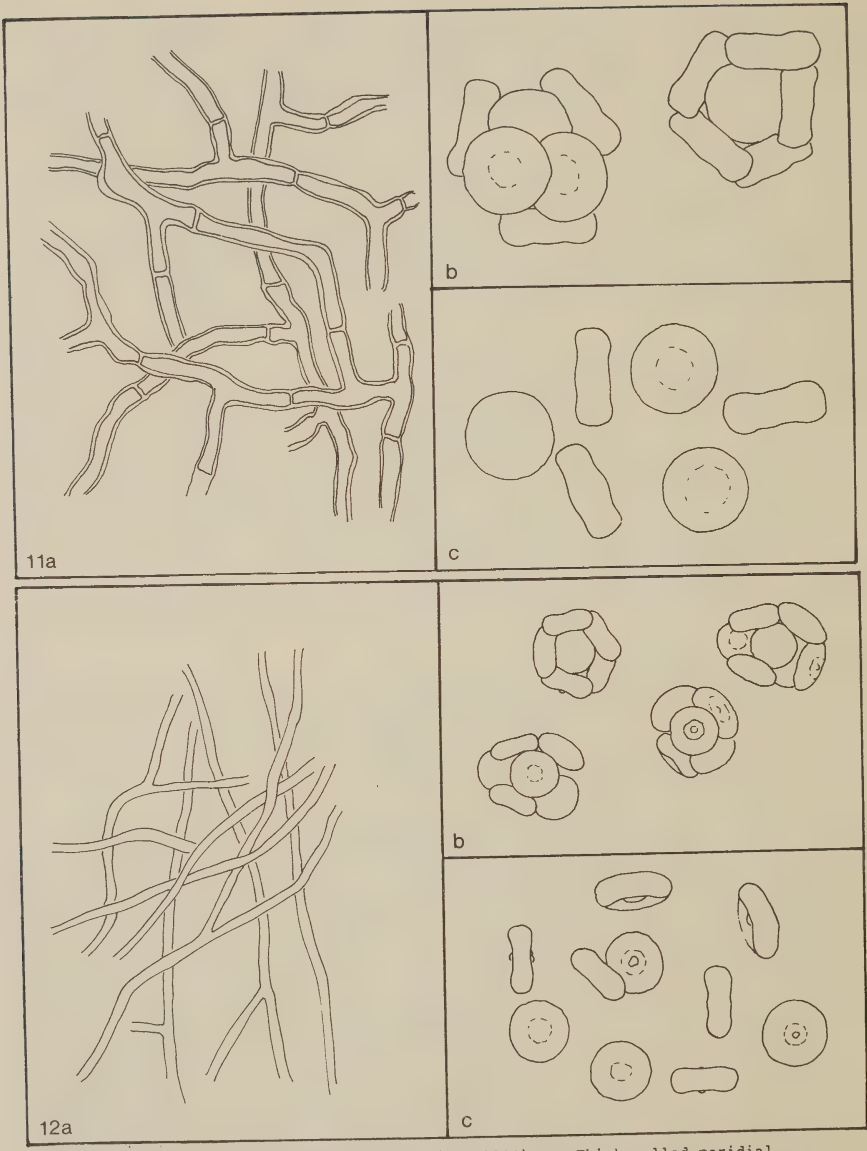
Type material: NEOTYPE (*cultura desiccata*) **NY** O-195 (soil, California) (Designated by Orr *et al., op. cit.*).

≡*Arachniotus citrinus* Massee and Salmon, Ann. Bot. **16**:162, 1902 FIG 86 and 88 (Basionym).

≡*Pseudoarachniotus citrinus* (Massee and Salmon) Kuehn, Mycologia **49**:699, 1957.

Ascomata: white at first, becoming deep lemon-yellow, 0.5-1mm, often confluent. **Ascospores:** lemon-yellow, smooth, thick-walled, oblate with thickened poles and an equatorial rim, almost rhomboidal in side view, 3-4.5 x 4-6*um*. **Asci:** hyaline, ovoid to subglobose, 8-15*um* diam. **Peridial hyphae:** scanty to absent, delicate, smooth, septate, 3*um* diam. **Anamorph:** lacking. **In culture:** [UAMH 3073, 3545]. **PDA 25°C** Mycelium white, fuzzy at first with pale yellow reverse; becoming lemon yellow in central region where mycelium becomes heaped and fluffy; margin remains white at 30 days. Plates were not covered after 30 days. On OAT, growth is bright citrine yellow, granular in central zone becoming felty toward the perimeter. [UAMH 3545]. CER 35/25°C ochre and felty at centre, grading into lemon-yellow, thinning to granular growth at perimeter; reverse bright yellow. DSA 42/25°C granular, yellow-brown; reverse yellow. PYE 42/25°C clay-brown and lemon-yellow zones, thick felty; reverse bright yellow.

Notes: The bright, lemon-yellow mycelial mat is a distinctive cultural feature. Von Arx (1971) lists *Arachniotus confluens* as a synonym of this species.



Figs 11-12. 11. *Gymnascella aurantiaca* (U 178821). a. Thick-walled peridial elements. X1175. b. Characteristic ±globose asci showing compact arrangement of ascospores. X2135. c. Ascospores showing variation in polar faces: some with slight boss-like thickenings, and others with shallow polar depressions. X2350. 12. *Gymnascella calcarea* (K Sydow 4031). a. Regular, thin-walled hyphae of the peridium. X470. b. Asci showing closely packed ascospores. X1890. c. Oblate, smooth, thick-walled ascospores with boss-like polar thickenings and flattened equatorial zones. X2350.

Gymnascella confluens, as described by Sartory and Bainier (1913 a and b), and neotypified by Apinis (1964),is easily distinguished from *Gymnascella citrina* on the basis of ascospore morphology.

Massee and Salmon (1902) observed this species on kangaroo dung. It is difficult to determine the characteristic habitat(s) of this taxon until more isolates are available.

Material examined: **FH** O-3056/dog/Texas; O-3339/?/?; O-3340/?/?; **UAMH** 3073/soil/Tennessee; 3545/soil/U.S.A., from Von Arx, CBS 114.54 (1972).

Gymnascella confluens (Sartory and Bainier) Currah, comb. nov.

Figs 14a,b,c 28b,d 29d

Type material: NEOTYPE (*cultura desiccata*) **BDUN** 375 (dung, England). (*fide* Apinis, 1964.

≡*Gymnoascus confluens* Sartory and Bainier, C. R. Soc. Biol. Paris **74**:498-500, 1913; Bull. Soc. Mycol. Fr. **29**:261-272 , 1913 PL XII FIG 1-8. (Basionym).

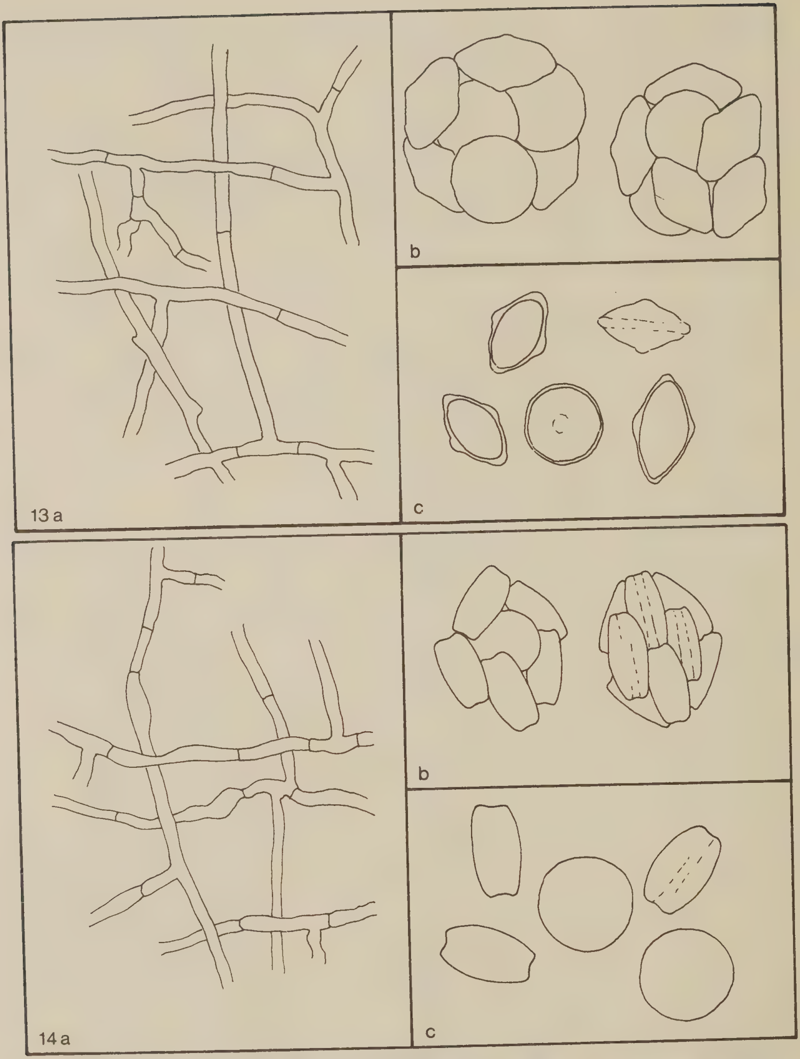
≡*Arachniotus confluens* (Sartory and Bainier) Apinis, Mycol. Pap. **96**:37-39, 1964.

=*Arachniotus desertorum* Moustafa, Trans. Brit. mycol. Soc. **61**:392-393, 1973 FIG 1-6.

≡*Pseudoarachniotus desertorum* (Moustafa) Orr, Ghosh and Roy, Mycologia **69**:158, 1977.

Ascomata: red-brown, 20-80um, confluent into tufts (yellow-brown) up to 500um diam. **Ascospores:** orange to yellow or brick-red (slightly encrusted) slightly lenticular to oblate, with a broad, shallow equatorial depression; thick-walled, smooth (or with granular material adhering), 3.3-4.6 x 5-6.5(-7.5)um. **Asci:** globose to subglobose or somewhat pyriform, 10-13um diam. **Peridial hyphae:** mostly hyaline, undifferentiated, some yellow-brown, branched, septate, slightly thick-walled elements, these ±heavily encrusted and sometimes constricted at septa. **Anamorph:** arthroconidia, 5-6 x 7.5-9.5um (infrequent). **In culture:** [UAMH 3565, 3763]. **PDA 25°C** At first white, cottony with pale yellow diffusible pigment; becoming yellowish to orange and finally with some olive tints, aerial mycelium scant; after 30 days reverse is brown. Plates covered in 25 days. On OAT aerial mycelium is yellowish to brown and granular; margin pale yellowish tan.[UAMH 3565]. CER 49/25°C cream to orange brown, wispy to slightly felty; reverse pale yellowish tan. DSA 42/25°C yellowish white, scant; reverse concolorous. PYE 28/25°C cream to pale brownish yellow, felty; reverse brown.

Notes: I have combined *Gymnascella confluens* and *Arachniotus desertorum* here. The type strain of *A. desertorum* was from halomorphic soil, Kuwait. (CBS 634.72 (IMI 163480). No holotype was designated by Moustafa, but the type strain is darker in color on most media and the ascospores are slightly larger (pole to pole) than the type strain of *Gymnascella confluens*. Differences between these strains do not merit maintaining them as distinct species. In an Alberta isolate from carnivore dung, the deep, rusty brown color of the fertile mycelium is very distinctive. The red color and equatorial depression on the ascospores make



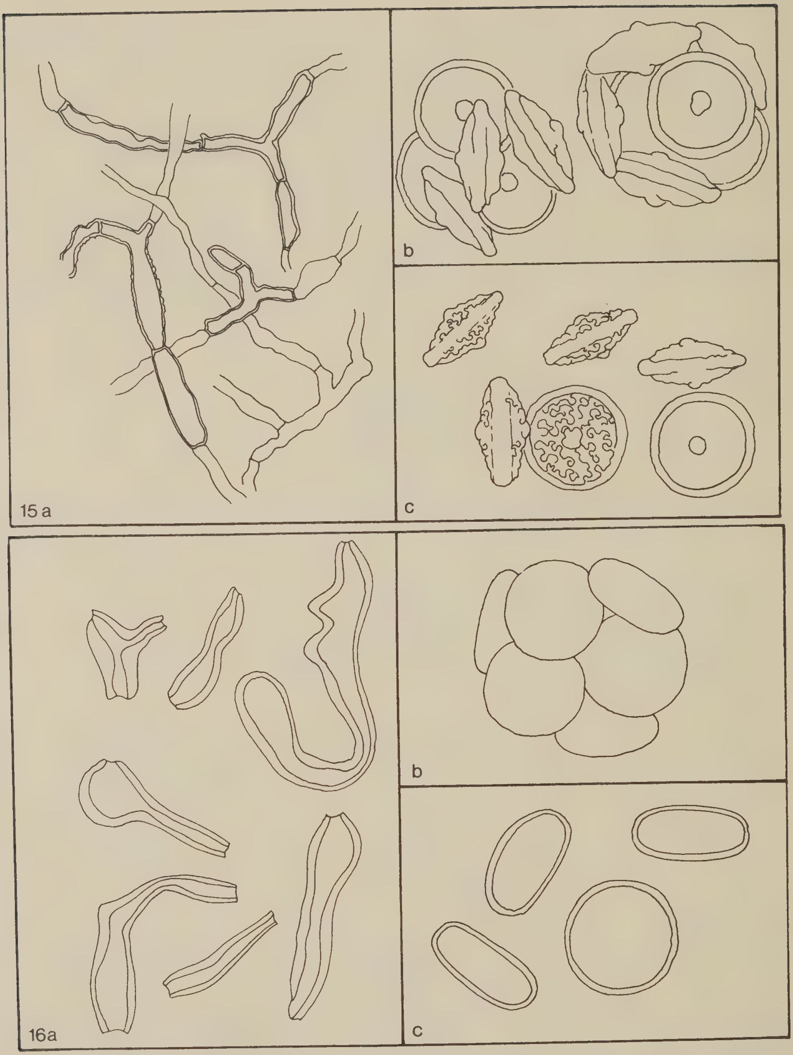
Figs 13-14. 13. *Gymnascella citrina* (UAMH 3545). a. Regular, thin-walled peridial hyphae. X630. b. Closely packed ascospores in ±globose asci. X2340. c. Smooth, thick-walled, ±oblate ascospores showing characteristic rhomboidal shape in side view. X2540. 14. *Gymnascella confluens* (RSA 1240). a. Thin-walled, slightly irregular hyphae which comprise the bulk of the peridium. X930. b. Closely packed ascospores in globose or ovoid asci. X1835. c. Smooth, thick-walled, oblate ascospores with ±flattened poles and broad, shallow equatorial depressions. X2480.

Gymnascella confluens similar to *Arachniotus ruber*. However the latter species is orange red on natural substrata and artificial media and close examination of the ascospores should provide a reliable distinction. *Gymnascella dankaliensis* is also similar in color but the ascospores have equatoria thickenings rather than a depression. *Gymnascella confluens* is predominantly coprophilous.

Material examined: as *Pseudoarachniotus desertorum*: **NY**, **FH**, **UAMH** 0-1160 (=UAMH 3763)/halomorphic soil/Kuwait; as *Pseudoarachniotus* sp.: **RSA** 1240/pack rat dung/California; as *Arachniotus ruber*: **TRTC** 35217/carnivore dung/Ontario; as "Gymnoascaceae" **TRTC** 31522/carnivore dung/Wyoming; as *Arachniotus confluens*: **ATCC** 21024/dung/Pakistan; **UAMH** 3565 from CBS 352.66 derived from BDUN 375 (type strain).

Gymnascella dankaliensis (Castellani) Currah, comb. nov.
Figs 1c, 15a,b,c 29b,c,e,f 31c
Type material: UAMH (**type strain**) 3552 (camel skin, Italy). (possibly no holotype).
≡*Trichophyton dankaliense* A. Castellani, Jour. Trop. Med. Hyg. **40**:315, 1937 Pl. 1-3. (Basionym).
≡*Arachniotus dankaliensis* (Castellani) van Beyma, Antonie van Leeuwenhoek 8:107, 1942.
=*Arachniotus flavoluteus* Kuehn and Orr, Mycologia 51:864, 1959.
≡*Pseudoarachniotus flavoluteus* (Kuehn and Orr) Orr, Ghosh and Roy, Mycologia **69**:155, 1977.
=*Waldemaria pernambucensis* Batista *et al.*, Atas Inst. Micol. (Recife) I:6, 1960 *fide* von Arx *loc. cit.*
=*Pseudoarachniotus flavus* Thirumalachar and Mathur, Mycopathol. et Mycol. Appl. **40**:97, 1970 *fide* von Arx *loc. cit.*
=*Pseudoarachniotus halophilus* Pawar *et al.*, Mycopathol. et Mycol. Appl. **40**:102, 1970 *fide* von Arx *loc. cit.*
=*Pseudoarachniotus terrestris* Thirumalachar and Mathur, Mycopathol. et Mycol. Appl. **40**:102 1970 *fide* von Arx *loc. cit.*
=*Pseudoarachniotus thirumalacharii* Mathur, Mycopathol. et Mycol. Appl. **40**:101 1970 *fide* von Arx *loc. cit.*
=*Pseudoarachniotus roseus* Kuehn, 1957 *fide* von Arx, Persoonia **6**:372, 1971.

Ascomata: orange-yellow to brownish orange clumps of ascospores surrounded by ±differentiated peridial hyphae, 80-600*u*m diam. **Ascospores:** yellow to orange or red-brown, oblate with equatorial and polar thickenings, surface irregular, (3)4.3-5.3 x 6-8*u*m. **Asci:** 8.2-12*u*m diam. **Peridial hyphae:** either undifferentiated from vegetative hyphae or occasionally thick-walled, somewhat gnarled, roughened, irregular hyphae. **Anamorph:** arthroconidia reported but not observed here. **In culture:** [UAMH 1919, 1995, 3532, 3552]. **PDA 25°C** Mycelium at first white with yellow tinge, tomentose becoming felty to funiculose with abundant aerial mycelium; soon radiately sulcate, yellow to yellowish brown with scattered patches or knots of darker orange brown (indicative of ascospore production). Some strains with little surface mycelium and tinged olive green. Plates covered after 25-30 days. On OAT orange-brown to rusty brown



Figs 15-16. 15. *Gymnascella dankaliensis* (NY 0-902). a. Gnarled, ±thick-walled, roughened hyphae of the peridium. X660. b. Oblate ascospores with polar and equatorial thickenings and characteristic irregular exterior wall surfaces. X2015. c. Asci containing closely packed ascospores. X2310. 16. *Gymnascella devroeyi* (RSA 1481). a. Short, irregular, disarticulated, thick-walled elements of the peridium. X1110. b. Ascospores closely packed in a ±globose ascus. X2015. c. Smooth, thick-walled, broad, oblate ascospores with ±flattened poles and equators. X2350.

with age, granular; reverse pale orange-brown from diffusible pigment. [UAMH 3532]. CER 56/25°C tan brown to granular; margin pale brown to cream, reverse concolorous. DSA 49/18°C white with hirsute brown centre; reverse concolorous. PYE 42/25°C reddish yellow, reticulate tufted; reverse reddish brown.

Notes: This species is combined here with *Arachniotus flavoluteus*. Distinction was based on ascospore color and size, but intergrading shades and sizes occur. I feel that the distinctive (and consistent) ascospore shape found in isolates under either name should be weighed against these variable characters. This species may be confused with *Gymnascella devroeyi* in gross cultural morphology. Spores of that species are much larger, lack the distinctive acute, thickened equatorial margin and are smooth-walled. Kuehn (1958) and Van Beyma (1943) refer to the production of round, brown hulle cells, 10-12µm diam. These were never observed in the present study. This species is apparently cosmopolitan and frequently coprophilous. Also found in other materials of animal origin.

Material examined: UAMH 1919/soil/Japan; 3552/camel skin/Italy (type strain received from von Arx CBS 117.38 (1972); 3532/soil/Sudan from CDC (1972); **NY** O-902/ulcerated chicken gizzard/Arizona; O-3467/human foot lesion/California; IMUR 924/human auditory canal/Brazil; as *Arachniotus* or *Pseudoarachniotus flavoluteus*: O-31/bat dung/India; O-121/bird dung/India; O-134, -1167, -1168, -1173, -1174/soil from cow shed/India; O-483/lizard dung/California; O-728/soil/Arizona (type of *Arachniotus flavoluteus*); O-1176/?/?; O-3172/human/India; O-3280/soil/West Pakistan; O-3286/human/India; O-3291/bat dung/India; O-3573/fox dung/India; O-3647/soil/Argentina; **TRTC** M 7143/soil/Egypt; as *Pseudoarachniotus roseus* **NY** O-433/?/California; O-731/rodent/Arizona; O-1123/dog hair/Dutch Antilles; O-1176/?/? O-1194/dog tick/SW Africa; O-2010/human skin/India; O-2515/soil/France; O-3091/soil/Pakistan; O-3180/soil/India; O-3189/soil/Somalia; O-3203/human ear/Brazil; O-3361/soil/California; O-3464/human foot/California; O-3524/human toenail/California; O-3538/ear canal/Curacao; O-3579/?/?.

Gymnascella devroeyi (Orr) Currah, comb. nov.

Figs 25c, 16a,b,c

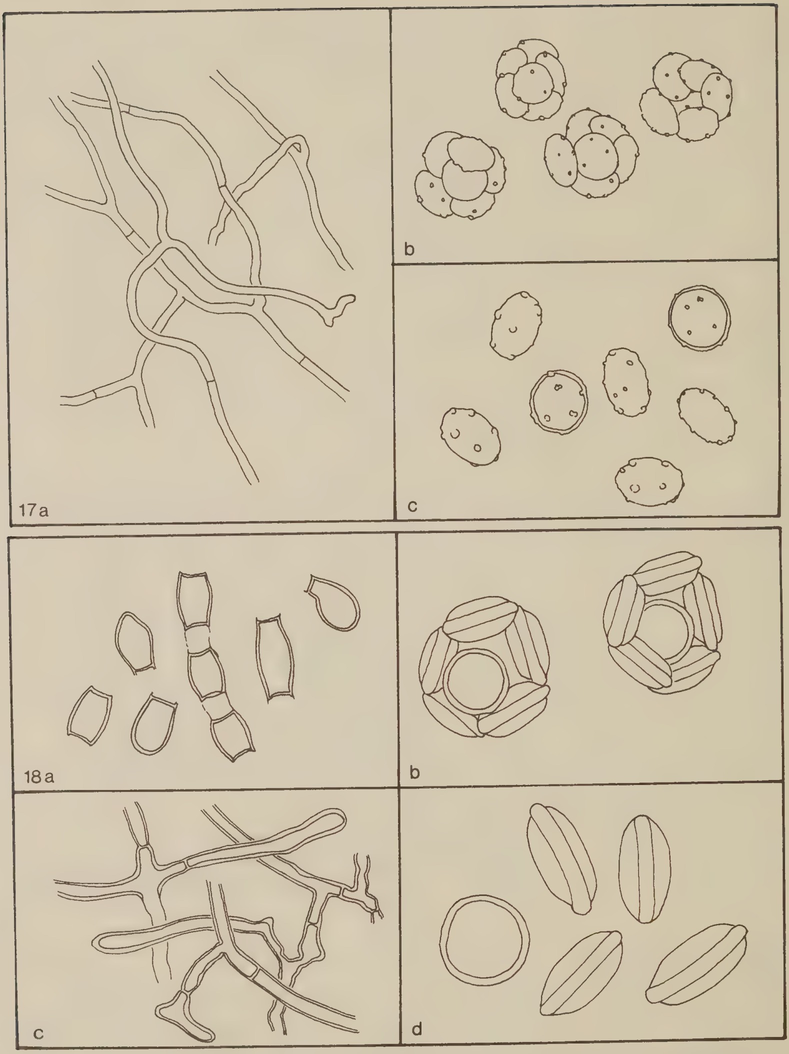
Type material: HOLOTYPE (*cultura desiccata*) **NY** O-3485 (soil, Somalia).

≡*Disarticulatus devroeyi* Orr, Mycotaxon **6**:35, 1977 (Basionym).

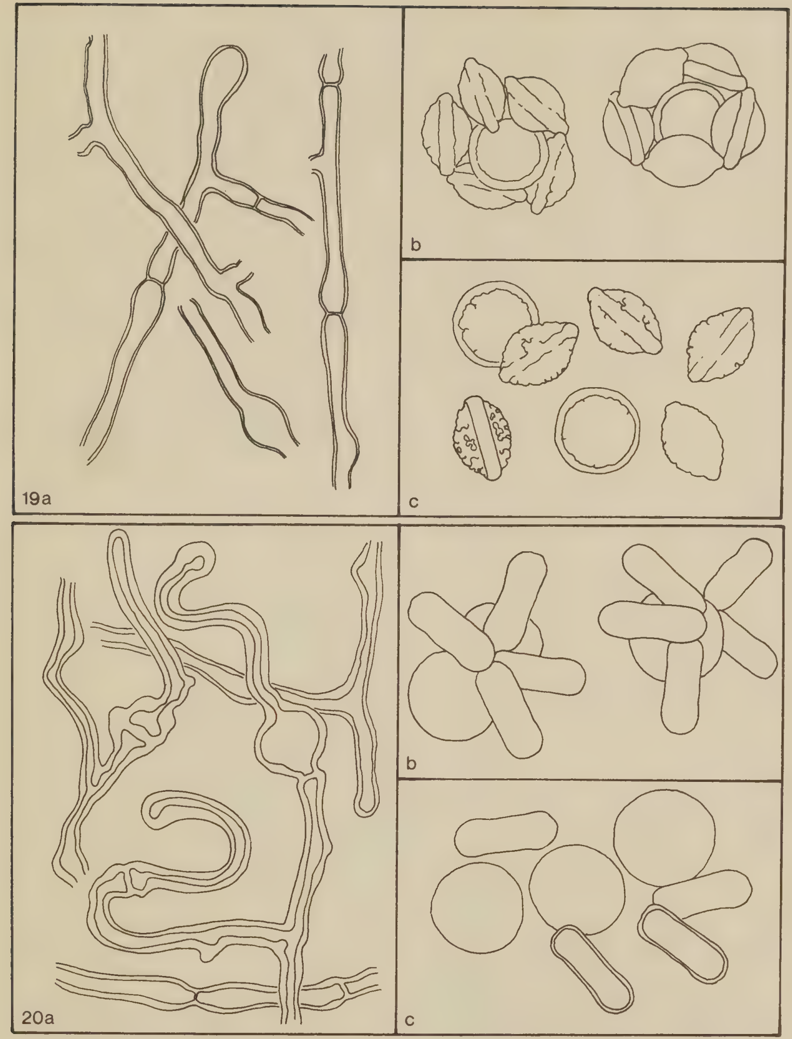
=*Disarticulatus indicus* Orr, Mycotaxon **6**:38, 1977.

≡*Arachniotus devroeyi* (Orr) von Arx, Persoonia **9**:397, 1977.

Ascomata: yellow-orange to orange, ±globose, 30-175µm diam. **Ascospores:** yellow-orange to orange or reddish brown, smooth, thick-walled, oblate, 3.4-4.5 x 5-8µm. **Asci:** globose, ellipsoid, 9.5-15(17)µm diam. **Peridial hyphae:** variously shaped, thick-walled (0.6-1.4µm) cells, 3.8-13 x 17-26µm, some with interior surface decorated with lateral



Figs 17-18. 17. *Gymnascella hyalinospora* (RSA 1529). a. Typical undifferentiated hyphae of the peridium. X470. b. Asci with closely packed ascospores. X2015. c. Sparsely warted, oblate ascospores. X3135. 18. *Gymnascella littoralis* (NY 0-3053). a. Smooth, thick-walled arthroconidia. X1645. b. Closely packed ascospores in characteristic ±globose asci. X1880. c. Smooth, ±irregular, somewhat thick-walled hyphae of the peridium showing slightly swollen, blunt ends. X785. d. Broadly oblate ascospores with flattened poles and equatorial thickenings. X3310.



Figs 19-20. 19. *Gymnascella marginospora* (ANSM QM 1327). a. Atypical peridial hyphae showing smooth, thick-walled elements of irregular diameter. X705. b. Closely packed ascospores in ±globose asci.X3290. c. Ascospores with irregular wall surface and prominent equatorial band. X3355. 20. *Gymnascella nodulosa* (UAMH 3162). a. Irregularly thick-walled elements showing swellings and constrictions at septa. X1035. b. Asci containing ascospores in characteristic petaloid arrangement. X3525. c. Smooth, oblate ascospores with flattened rims. X3230.

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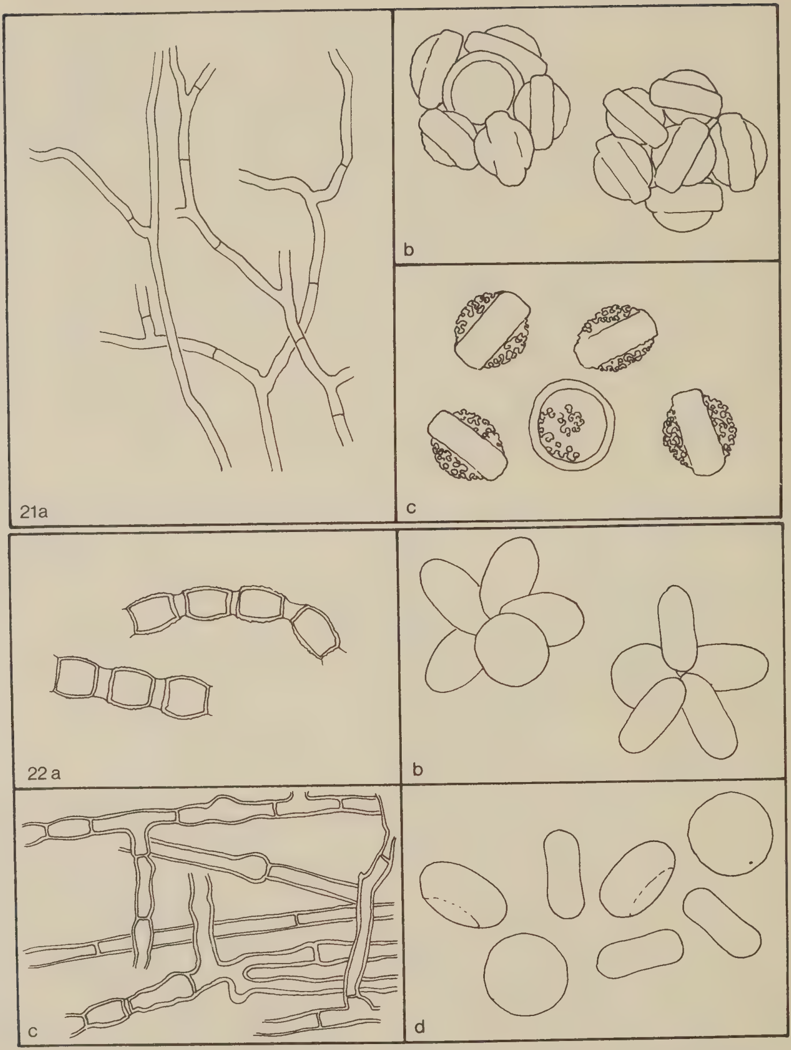
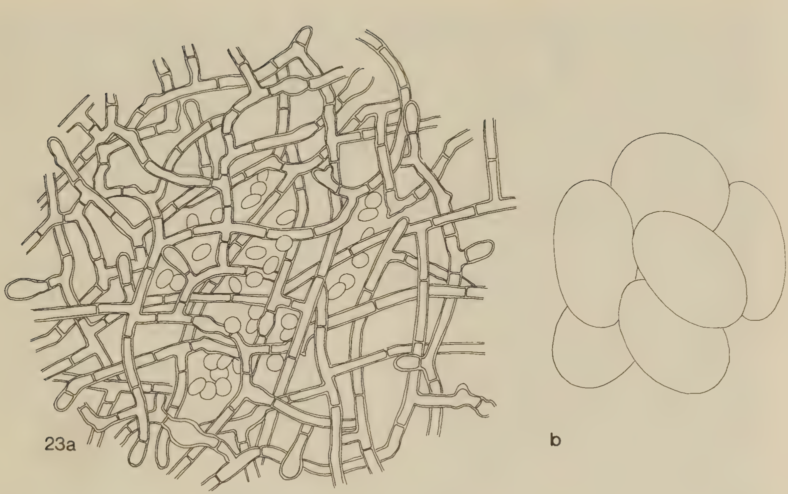
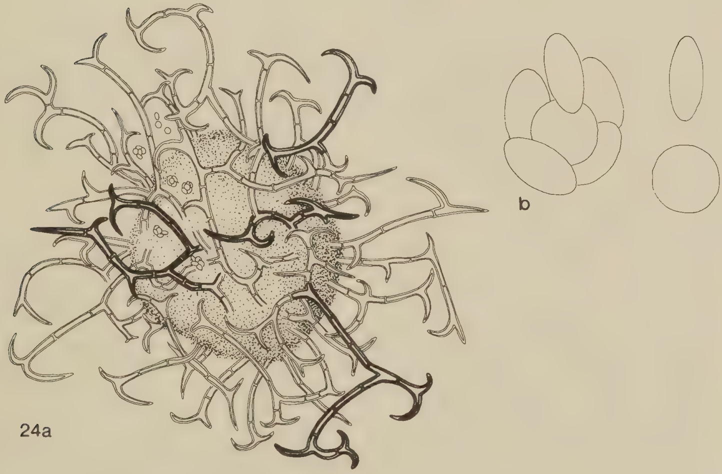


Figs 21-22. 21. *Gymnascella punctata* (UAMH 1544). a. Regular peridial hyphae undifferentiated from vegetative hyphae. X470. b. Asci showing closely packed ascospores. X2400. c. Ascospores with irregularly convoluted walls and broad equatorial margin. X1810. 22. *Gymnascoideus petalosporus* (UAMH 1665). a. Thick-walled, finely roughened arthroconidia of *Malbranchea* anamorph. X940. b. Asci showing petaloid arrangement of ascospores. X3670. c. Thick-walled peridial hyphae; some areas irregular in width. X1855. d. Smooth, thick-walled, oblate ascospores. X4290.





Figs 23-24. 23. *Gymnoascus intermedius* (NY O-313). a. Section of confluent ascomatal mass, showing right-angle branching of thick-walled peridial elements. X435. b. Smooth, conglobate, oblate ascospores. X3820. 24. *Gymnoascus reessii* (Ground squirrel dung, southern Alberta, Uncatalogued). a. Ascoma showing distinctive arrangement of thick-walled peridial hyphae and appendages of the reticuloperidium. X95. b. Smooth-walled oblate ascospores, narrowed at the margin. X3175.

grooves, disarticulating readily; forming an incompositoperidium. **In culture:** [UAMH 3136]. CER 21/25°C bright rusty orange, zonate, evenly granular; reverse deep rusty-red. DSA 49/25°C scattered granular patches of mycelium; reverse colored by abundant orange diffusible pigment. PYE 35/25°C deep brownish red, granular: reverse appearing black.

Notes: This is an extremely distinctive but rarely isolated species. The comparatively large ascospores and unique, thick-walled, disarticulating peridial hyphae are not so pronounced in any other species of *Gymnascella*. *Disarticulatus indicus* is considered a synonym since the type strain exhibits only minor differences in size of the disarticulated peridial hyphae. Unfortunately, cultures of this species were not studied in detail for this paper.

Material examined: FH, NY O-3485/soil/Somalia (type as cited); **NY** 3475/soil/Somalia; as Gymnoascaceae **RSA, UAMH** 1481 (=UAMH 3136)/rabbit dung/Colorado; as *Disarticulatus indicus* **FH** /O-1089/bat dung/India; **NY** O-951/soil/India; **FH, NY** O-1130, -1131/soil/India.

Gymnascella hyalinospora (Kuehn, Orr and Ghosh) Currah, comb. nov.

Figs 17a,b,c 31d

Type material: Type strain **RSA** 1529 and **UAMH** 3155. (Possibly no holotype).

≡*Pseudoarachniotus hyalinosporus* Kuehn, Orr and Ghosh, Mycopathol. et Mycol. Appl. **14**:215-229, 1961 (Basionym).

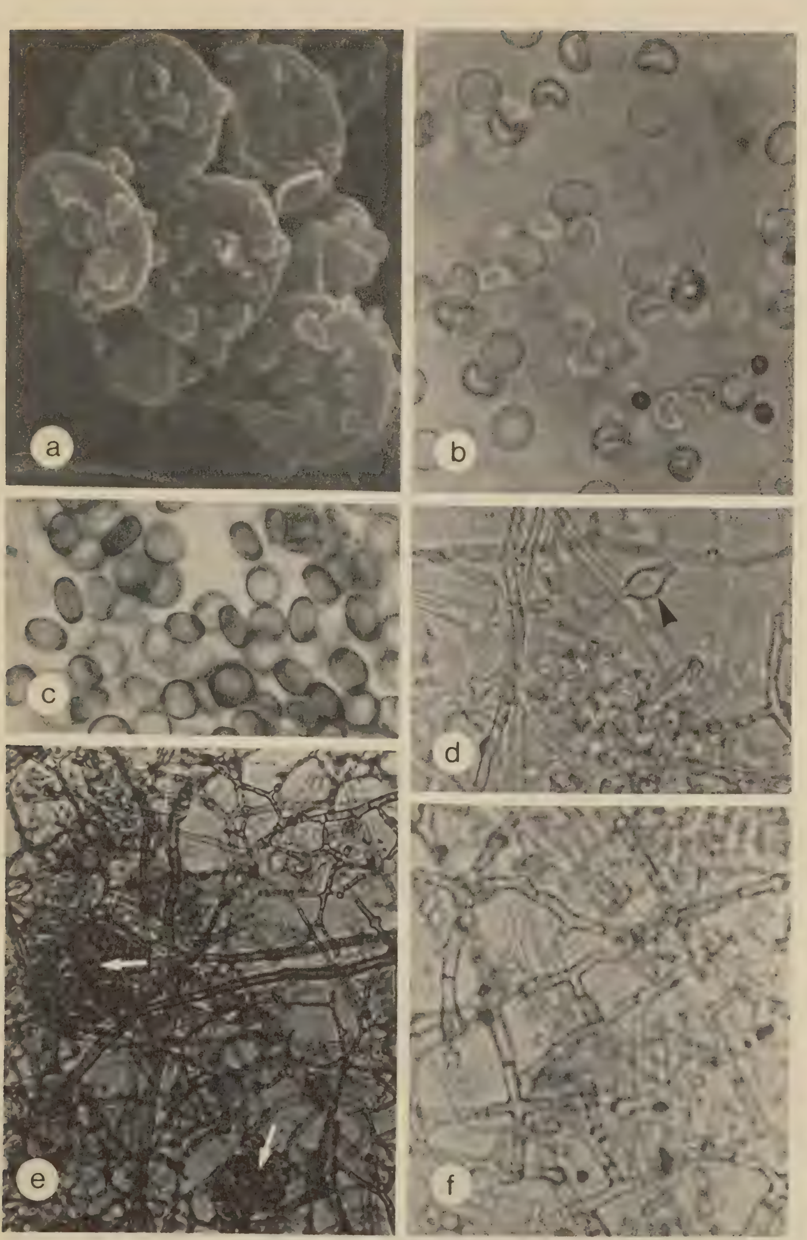
≡*Arachniotus hyalinosporus* (Kuehn, Orr and Ghosh) Apinis, Mycol. Pap. **96**:41, 1964.

≡*Narasimhella hyalinospora* (Kuehn, Orr and Ghosh) von Arx, Persoonia **6**:373, 1971.

≡*Rollandina hyalinospora* (Kuehn, Orr and Ghosh) Roy *et al.*, Kavaka, 1977 (not seen).

Ascomata: discrete ascomata absent, groups of asci 20-88μm. **Ascospores:** hyaline to pale yellow, ovoid to oblate, appearing smooth but with scattered warts visible under oil, (1.8)2.2-2.5 x 2.5-3.3μm. **Asci:** ±globose, 5.5-8.8μm diam. **Peridial hyphae:** undifferentiated, or with some slightly thick-walled and pigmented hyphae, 3.5-5μm.

Fig. 25. a. *Gymnascella calcarea* (TRTC Sydow 4031). Conglobate ascospores. X6840. b. *Diehliomyces microsporus* (PREM 33387). Smooth, globose, thin-walled ascospores with central oil droplet. X995. c. *Gymnascella devroeyi* (RSA 1481). Oblate, smooth, thick-walled ascospores. X940. d. *Gymnoascus intermedius* (TRTC 45468). Arrow indicates swollen element of peridial hypha. X515. e. *Gymnoascus intermedius* (TRTC 45468). Extensive development of thick-walled, straight peridial hyphae. Arrows indicate location of clusters of asci. X260. f. *Gymnoascus intermedius* (TRTC 45468). Branches of peridial hyphae are at right angles. X515.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Anamorph: scattered reports of the occasional occurrence of arthroconidia but none observed during this study. **In culture:** [UAMH 3125, 3126, 3127, 3148, 3155]. **PDA 25°C** At first glabrous, white with no diffusible pigment; becoming off-white to pale yellow with some green tints, funiculose and slightly radiately wrinkled; reverse yellowish becoming orange brown. Colonies commonly sectoring into: 1. yellowish orange, glabrous; reverse opaque; and 2. yellowish, cottony, reverse reddish brown. [UAMH 3155]. CER 77/25°C pale yellow with darker yellow patches, felty; reverse red brown. DSA 42/25°C pale cream, growth sparse; reverse uncolored. PYE 56/25°C yellow with distinct greenish areas; reverse dark reddish brown.

Notes: The original description (Kuehn *et al.*) explains that: "racquet mycelium often form upright fascicles or coremiform stalks to 1 cm in length - often with green pigment." The habit of developing apical caps of yellow fertile tissue may have led to the disposition of this taxon in *Rollandina*. *Rollandina capitata* was described by Patouillard in 1905 for material found on plant debris collected in North Viet Nam (Tonkin). He placed it in the Gymnoascaceae, since the "ascigerous glomerules resemble fruit bodies of Gymnoascaceae." Benjamin (1956) emended the genus after carefully analysing the type material (FH) by making sections of the entire fruiting structure (consisting of a sterile stalk and a capitulum containing ascospores). In a reexamination of this material Apinis (1968) determined that there were two species making up the fruiting body, a conclusion which is supported in part in this study (in fact, there may have been more than 2 species present). The ascospores found in the capitulum resemble those of *Gymnascella marginospora*. However, the original name was applied to both (if not more than 2 species present) fungi comprising the stalked fruiting body. Von Arx (1977) suggested that *Rollandina* be considered a *nomen confusum* and this is supported here. Apinis *op. cit.* placed two keratinolytic species in *Rollandina*. These are discussed under *Nannizziopsis* of the Onygenaceae.

Material examined: RSA 1486 (=UAMH 3141)/lizard dung/Mexico; 1503/lizard dung/Mexico; **UAMH** 1605/soil/California; 3148 (=RSA 1502); 3137 (=RSA 1482); 3126 (=RSA 1443); 3125 (=RSA 1442); 3127 (=RSA 1444)/lizard dung/Mexico; 3155 (=RSA 1529)/guinea pig dung/India from NRRL 2881 (type strain from Benjamin (1969)); 3120 (=RSA1437)/lizard dung/Mexico; **NY** O-733 (=RSA 1529, =NRRL 2881/guinea pig dung/India (type strain); **RSA** 1503/lizard dung/Mexico; as *Rollandina hyalinospora* **NY** O-57/mouse dung/India; O-254; O-269/cheese/India; O-283/rat dung/India; O-285; O-288/soil/California; O-311/fox dung/California; O-757/lizard dung/California; O-821/goat dung/India; O-874/pack rat dung/California; O-3052/gull dung/Mexico; O-3265/soil/India; O-3329/soil/Kentucky; O-3338/soil/Arkansas; O-3368/soil/Uruguay; O-3425/feathers/Queensland; O-3450/soil/Italy; O-3478/soil/Belgium; O-3650/soil/England.

Gymnascella littoralis (Orr) Currah, comb. nov.

Figs 18a,b,c,d 26b

Type material: HOLOTYPE (*cultura desiccata*) **NY** O-3053 (conch shell, British Columbia).

≡*Plunkettomyces littoralis* Orr, Mycotaxon **6**:33, 1977 (Basionym).

≡*Arachniotus littoralis* (Orr) von Arx, Persoonia **9**:397, 1977.

Ascomata: yellow to orange-brown, globose, 35-155um diam., often confluent. **Ascospores:** yellow-brown to orange-brown, smooth, thick-walled, oblate with equatorial rim, 0.3-0.6um wide, 2.9-3.8 x 4.2-5.7um. **Asci:** ±globose, to 11um diam. **Peridial hyphae:** hyaline or yellow, simple or branched, smooth slightly thick-walled, 2.1-3.3um diam. **Anamorph:** smooth-walled arthro- and aleurioconidia, 2-2.8 x 3.5-7um. **In culture:** [UAMH 3885]. **PDA 25°C** At first hyaline to white, slow growing; reverse uncolored; becoming pale rosy yellow or orange, closely appressed; reverse tinged orange. Finally peach-colored with pale brown patches; reverse orange brown. Plate covered in 20 days. CER 14/25°C orange-pink in centre, elsewhere pale orange yellow, fuzzy; reverse yellow. DSA 42/25°C pale with orange-red tinge, sparse, fuzzy. PYE 14/25°C creamy yellow, felty or fuzzy; reverse orange brown.

Notes: Known only from substrates obtained from marine habitats, west coast of North America.

Material examined: NY, FH, UAMH O-3053 (=UAMH 3885)/conch shell/British Columbia (type strain); **FH, NY** O-3050/crab shell/Mexico; O-3051/snail shell/British Columbia; O-3074/crab shell/California; O-3078/coral/Mexico; **FH** O-3076/insect carapace/Mexico; **NY** O-3065/red alga/California; **UAMH** 3863 (=O-3055)/sea anemone/Mexico.

Gymnascella marginospora (Kuehn and Orr) Currah, comb. nov.

Figs 19a,b,c 30a,b,c 31a

Type material: Possibly no type.

≡*Pseudoarachniotus marginosporus* Kuehn and Orr, Mycopathol. et Mycol. Appl. **19**:257, 1963 (Basionym).

=*Narasimhella poonensis* Thirumalachar and Mathur, Sydowia 19:184, 1965.

≡*Arachniotus marginosporus* (Kuehn and Orr) Udagawa, Trans. Mycol. Soc. Jap. **10**:103-104, 1970.

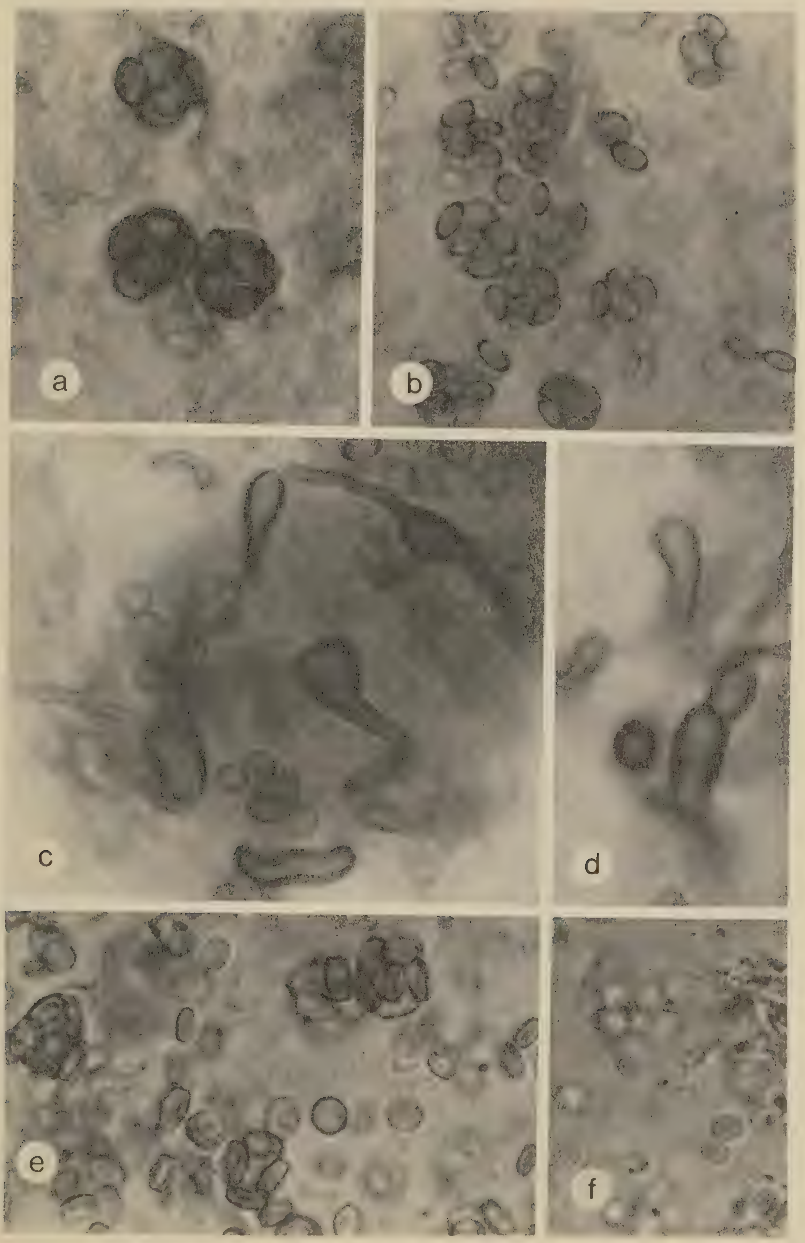
Ascomata: spherical, 50-150um diam. when discrete; often no more than clusters of ascospores among vegetative hyphae. **Ascospores:** yellow-orange, oblate, (sometimes appearing lenticular in side view); walls thick, smooth or slightly rough (due to surface convolutions of ascospore wall), with a slender equatorial rim (2.2)2.5-3um x 3-3.8(4.4)um. **Asci:** globose to subglobose, 7-8um diam. **Peridial hyphae:** mostly undifferentiated from vegetative hyphae but some smooth, thick-walled elements occur in some isolates. ANSM QM 1327 from linen, (and ATCC "Shear") has well-developed, thick-walled hyphae scattered among the ascospores. These are illustrated in figure 19. **Anamorph:** few hyaline arthroconidia, 2.2-4.4 x 5.5-7um.**In culture:** [UAMH 1902, 3533, 3534]. **PDA 25°C** Creamy white and slightly powdery at first; reverse uncolored; becoming pale yellow with scattered spots of orange (most numerous near the centre), cottony and strongly funiculose, concentrically zonate; reverse yellow-brown to brown. Plates covered in 7-9 days. On OAT, rusty orange felty or granular, cracking; reverse dark orangish tan. [UAMH, 1902]. CER 14/25°C numerous, crowded, spherical, orange, minutely stalked tufts of ascospores and vegetative hyphae; reverse orange brown. DSA 34/25°C scattered knots of orange brown; reverse concolorous. PYE 14/25°C as on CER but darker orange; margin bright yellow.

Notes: This species slightly resembles *Gymnascella dankaliensis* but differs in having smaller ascospores which are proportionately thicker (pole to pole). The polar thickenings or bossae found in *Gymnascella dankaliensis* are lacking in *Gymnascella marginospora*. Colouration on artificial culture media and on natural substrata resembles *Arachniotus ruber* and *Gymnascella confluens*. Close examination of the ascospores is essential for accurate identification. Many workers consider *Gymnascella punctata* synonymous with this species, but its ascospore morphology and cultural characters are quite different. These are discussed under that taxon. This is probably the most common and widespread species in the genus. It is found in soil, dung and other materials derived from animals.

Material examined: as *Arachniotus aureus* **ATCC** C. L. Shear/buzzard's stomach/Maryland; as *Arachniotus ruber* **ANSM** QM 1327/linen/?; **FH** BCI/?/Panama; as *Narasimhella hyalinospora* **UAMH** 3533 (=ATCC 15314)/buried cable/?; 3534 (=CBS 393.71)/soil/India; as *Pseudoarachniotus marginosporus* **NY** O-729/soil/Pennsylvania; NRRL 2850/?/Michigan; as *Rollandina capitata* **NY** O-112/soil/India; O-879/?/?; O-962/human/India; O-1083/?/India (neotype of *Rollandina capitata*); O-2509, -2542/soil/Panama; O-2591/marine sludge/Japan; O-3058/soil/Japan; O-3063/soil/Panama; O-3218/soil/Argentina; O-3333/soil/Italy; O-3450/?/? O-3589/soil/California; as *Rollandina hyalinospora* O-194/mouse dung/India; O-616, -963/bat dung/India; O-2055/tiger dung/California; O-3011/rabbit dung/India; O-3331/?/?; O-3428/?/?; **UAMH** 1902 from Orr as RSA 430 (1964).

Gymnascella nodulosa (Ghosh, Orr and Kuehn) Currah, comb.

Fig. 26. a. *Gymnascella citrina* (UAMH 3545). Typical globose asci. Ascospores have polar thickenings and slightly irregular (lumpy) surfaces. X1295. b. *Gymnascella littoralis* (NY O-3885). Smooth, flattened-oblate, thick-walled ascospores with equatorial band, and asci. X975. c. *Gymnascella nodulosa* (RSA 1552). Smooth, thick-walled, nodulose peridial hyphae. X1040. d. *Gymnascella nodulosa* (RSA 1552). Thick-walled, swollen element with constriction at septum. X1040. e. *Arachniotus ruber* (FH dog dung, Argentina). Pulley-wheel shaped ascospores and globose asci. X940. f. *Talaromyces flavus* (TRTC date 1958). Thick-walled, spiny, ovoid ascospores. X945.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Figs 20a,b,c 26c,d

Type material: HOLOTYPE (*cultura desiccata*) **NY** O-735 (mouse dung, India). (O-735 also assigned to an isolate from guinea pig dung, India).

≡*Petalosporus nodulosus* Ghosh, Orr and Kuehn, Mycopathol. et Mycol. Appl. **21**:36, 1963 (Basionym).

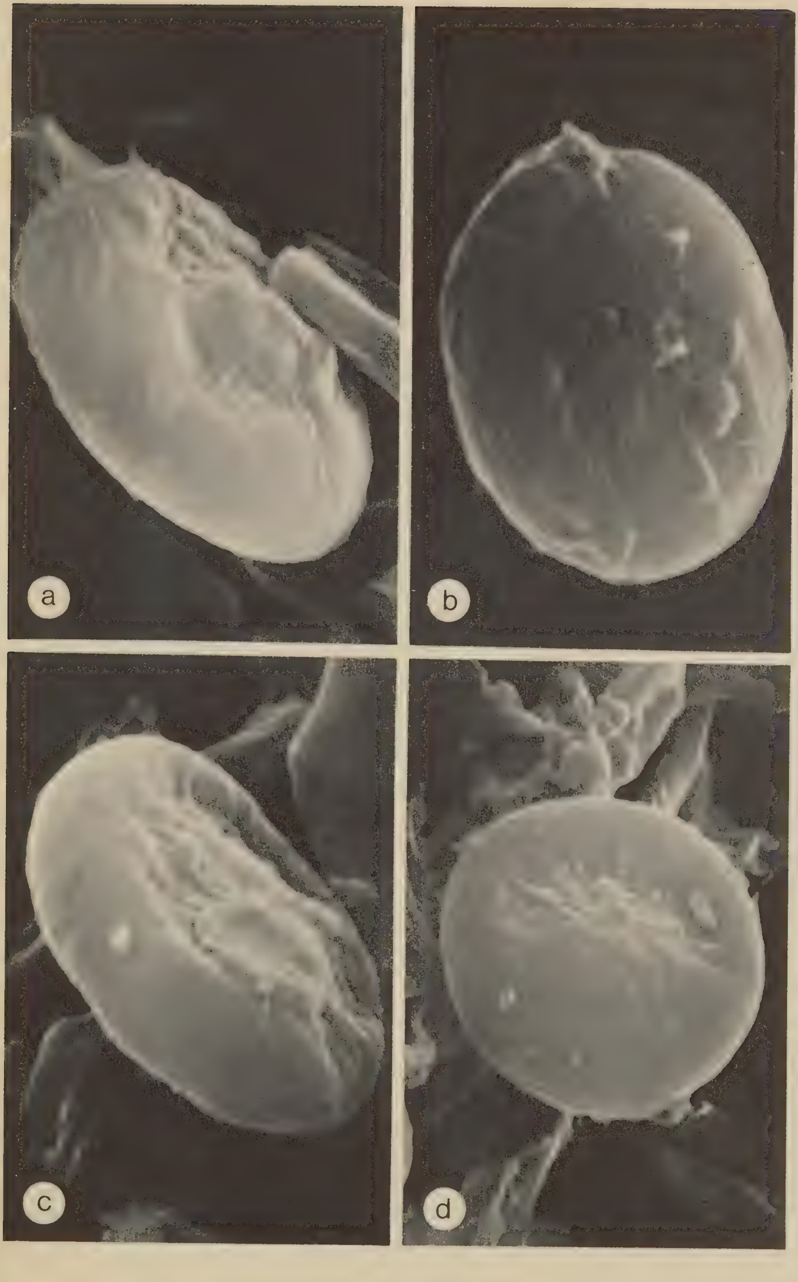
=*Petalosporus anodosus* Kuehn, Orr and Ghosh, Mycopathol. et Mycol. Appl. **23**:30, 1964.

Ascomata: golden yellow to golden brown, discrete, <1000*u*m, sometimes confluent. **Ascospores:** golden yellow, oblate, smooth, thick-walled, 2.1-2.3 x 3.8-5.2*u*m. **Asci:** petaloid ascospore clusters, to 12*u*m diam. **Peridial hyphae:** few to many golden yellow, irregularly thick-walled elements with swellings to 10-12*u*m diam., ±constrictions at septa, **Anamorph:** lacking. **In culture:** [UAMH 3161, 3162, 3769]. **PDA 25°C** At first white, glabrous to minutely pubescent becoming rather pasty, olive green and radiately sulcate; some white aerial mycelium with occasional yellow tufts indicating ascosporulation. Reverse pale olive green after 30 days. On OAT pale yellow to pale brown granular patches of mycelium develop unevenly over the surface of the agar. [UAMH 3162]. CER 42/25°C brown to buff in centre, elsewhere pale cream-yellow, felty; reverse purple-brown to black. DSA 42/25°C scant hyaline growth; reverse uncolored. PYE 42/25°C tan to buff with yellow and olive shades; reverse olive-brown.

Notes: This taxon is considered by von Arx (1981) assignable to *Arachniotus citrinus* (here *G. citrina*). In fact, these two species are quite different. It is closest to *Gymnascella aurantiaca* but may be readily distinguished by the petaloid arrangement of the ascospores in the asci. Kuehn *et al.* (1964) described *Petalosporus anodosus* but did not satisfactorily distinguish the type from *Petalosporus nodulosus*. Representative strains of his new species displayed enough variation in culture to raise some doubts about the species concept he was using. In culture, the strains of each taxon are strikingly similar and there is no adequate basis for maintaining the two under separate names. The third species originally described in the genus *Petalosporus* has been assigned here to *Gymnascella afilamentosa*.

Material examined: as *Petalosporus anodosus*: **UAMH** 3161/fox dung/California; 3769/?/Arizona; as *Petalosporus nodulosus*: **UAMH** 1985; 3162 from Benjamin as RSA 1552.

Fig. 27. a. *Gymnascella aurantiaca* (UAMH 3529). Smooth, thick-walled, oblate ascospore showing concavity with central thickening on polar face. X16200. b. *Gymnoascoideus petalosporus* (UAMH 1665). Smooth, thick-walled oblate ascospore. X11760. c. *Gymnascella aurantiaca* (UAMH 3529). Smooth, oblate ascospore with polar concavity and some irregular polar thickening. X16200. d. *Gymnascella aurantiaca* (UAMH 3529). Central thickening in slight concavity in polar face. X13320.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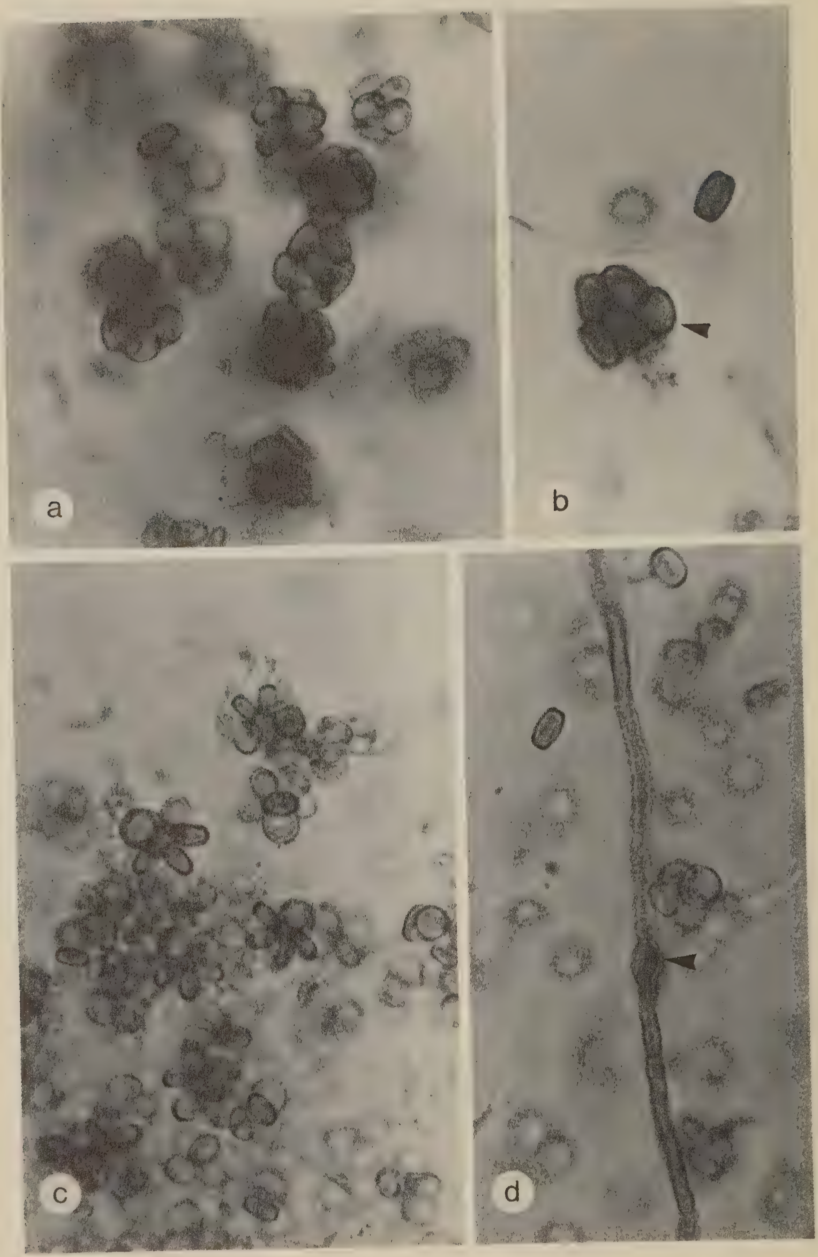
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Gymnascella punctata (Dutta and Ghosh) Currah, comb. nov.
Figs 21a,b,c 30d, 31b
Type material: HOLOTYPE (*cultura desiccata*) **NY** O-G-9 (rice paddy soil, India).
≡*Pseudoarachniotus punctatus* Dutta and Ghosh, Mycologia **56**:153, 1964 (Basionym).
≡*Arachniotus punctatus* (Dutta and Ghosh) von Arx, Persoonia **6**:373, 1971.

Ascomata: pale to bright pink becoming rusty orange, up to 250um across when single; globose to very irregular, usually confluent in culture. **Ascospores:** brownish yellow, thick-walled, surface irregular, 3.4-4 x 4.8-5.5um, with a very broad equatorial band approximately 1.5um thick and representing approximately 1/3 of the spore width. **Asci:** ±globose, 10um diam. **Peridial hyphae:** lacking or undifferentiated. **In culture:** [UAMH 3530]. **PDA 25°C** At first white, glabrous; becoming yellowish to pale orange in central area, elsewhere white, felty to granular; deep blue green diffusible pigment produced. Plate covered in 10 days. On OAT central area becomes densely felty, orange brown; reverse dark orange brown. CER 35/25°C pale orange, scant hyphae; reverse tinted yellow. DSA 49/25°C broad orange, granular halo; central region hyaline to pale yellow; reverse concolorous. PYE 49/25°C orange, felty, with white knots of overgrowth; reverse orange, tinted olive.

Notes: This species is quite distinct from *Gymnascella marginospora* which has similar ascospores, but a much more slender equatorial band and less irregular ascospore walls.

Material examined: NY, RSA, UAMH O-G-9 (=UAMH 3164 and 3530, =RSA 1544) (type strain as cited).

GYMNOASCOIDEUS Orr, Roy and Ghosh, 1977
Mycotaxon **5**:460.

Type species: *Gymnoascoideus petalosporus* Orr, Roy and Ghosh *op. cit.*

Ascomata: brown to greenish brown, discrete to confluent, globose, rarely greater than 1000um diam. **Ascospores:** yellow to yellow-brown, oblate, smooth-walled, 1.4-3.5 x 3.5-4.9um diam. **Asci:** ascospores disposed in a petaloid pattern, clusters ±globose to subglobose, to 10um diam. **Peridial hyphae:** smooth-walled, anastomosed and branched at right angles, free apices blunt. **Anamorph:** arthroconidia.

Notes: Von Arx (1977) considered this taxon (as "*Gymnoascoides*") intermediate between *Arachniotus* and *Gymnoascus* and placed the type species in the latter genus.

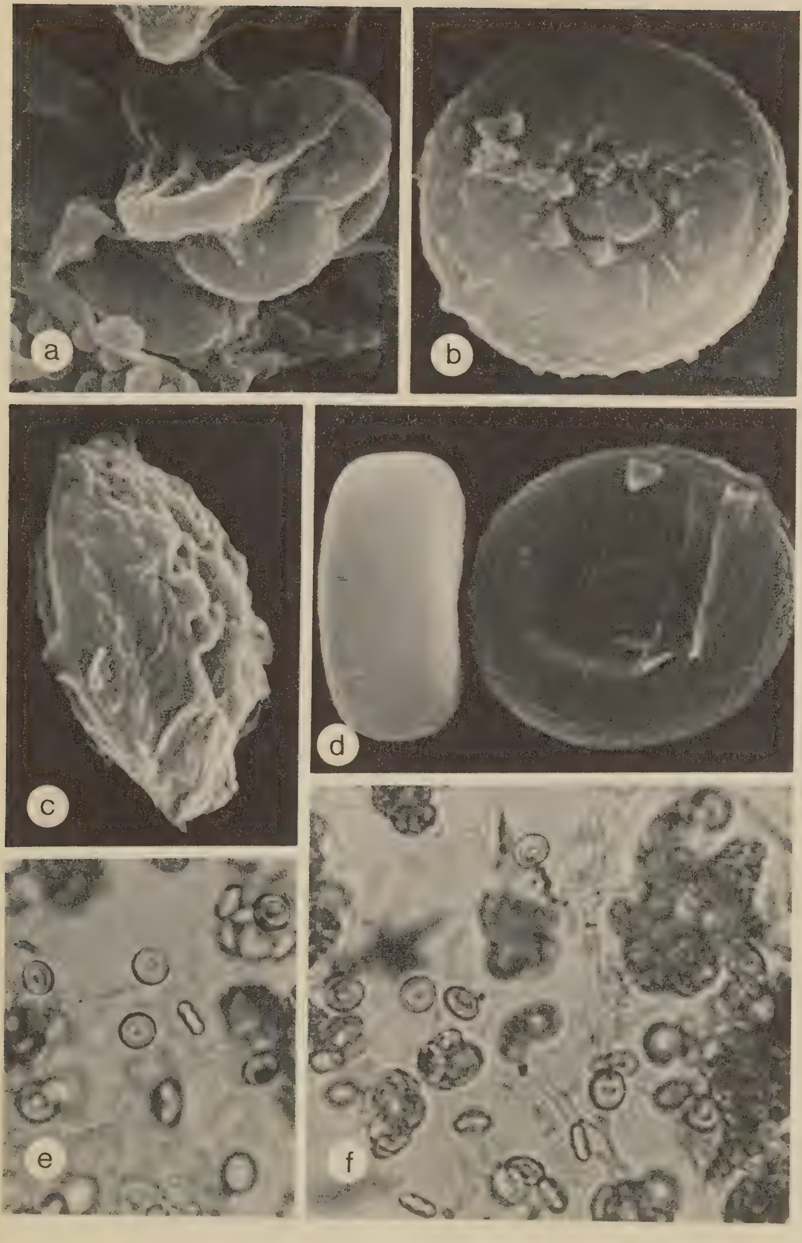
Fig. 28. a. *Gymnascella aurantiaca* (U 178821B). Ascospores in conglobate ascal clusters. X1150. b. *Gymnascella confluens* (RSA 1240). Individual ascospore in equatorial view showing broad marginal furrow. Conglobate ascospore cluster indicated by arrow. X1200. c. *Gymnascella afilamentosa* (NY O-2601). Petaloid clusters of smooth oblate ascospores. X1100. d. *Gymnascella confluens* (RSA 1240). Thick-walled hypha with ampulliform swelling (arrow). X1155.

The intermediate nature of the taxon is certainly supported by the nature of the peridium and morphology of the ascospores. Nevertheless, the species lacks the distinctive peridial appendages characteristic of *Gymnoascus reessii*. The ascospores of *Gymnoascoideus petalosporus* have a flattened equator in contrast to the smooth tapering margin of the oblate ascospores of *Gymnoascus reessii*. Further, *Gymnoascus* lacks an anamorph whereas *G. petalosporus* produces numerous arthroconidia. The consistently well-developed, regular, thick-walled peridial hyphae prevent considering this taxon in *Arachniotus* or in *Gymnascella*.

Gymnoascoideus petalosporus Orr, Roy and Ghosh, 1977
Mycotaxon **5**:460-461 FIG 1-20.
Figs 1a 22a,b,c,d 27b
Type material: HOLOTYPE (*cultura desiccata*) **NY** O-3325 (nodular cyst of human, India).
≡*Gymnoascus petalosporus* (Orr, Roy and Ghosh) von Arx, Persoonia **9**:387 1977.

Ascomata: brown to greenish brown, discrete to confluent, globose, 150-750*u*m diam. **Ascospores:** yellow to yellow-brown, smooth, thick-walled, oblate, 1.3-3.3 x 2.6-4.9*u*m diam. **Asci**: globose to subglobose, 8.4-10*u*m diam. **Peridial hyphae:** hyaline or very pale buff, smooth, thick-walled, anastomosed and branched at right angles, free apices blunt, 2.5-4.5*u*m. **Anamorph:** arthroconidia numerous, thick-walled, finely verrucose, hyaline, buff or pale brown, irregular in size, 1.4-4 x 2-5.5*u*m. **In culture:** [UAMH 1665, 1712, 3525, 3592, 3593, 3656, 3704, 3766, 3908]. **PDA 25°C** At first hyaline soon becoming pale orange, cottony; reverse yellow; becoming tan, granular with development of ascospores, zonate; reverse yellow-brown becoming red brown and finally dark brown at 30 days. On OAT, mycelium is tan and granular in patches. Plate covered in 10 to 15 days. [UAMH 1665]. CER 14/25°C scattered patches of buff to cream brown, felty mycelium; reverse bright yellow. DSA 35/25°C scattered white knots of hyphae, reverse uncolored. PYE 14/25°C thick, felty mat of cream to buff brown mycelium; reverse bright yellow-brown.

Fig. 29. a. *Gymnascella afilamentosa* (UAMH 3427). Petaloid cluster of smooth-walled, oblate ascospores. X5400. b. *Gymnascella dankaliensis* (UAMH 3531). Face view of a typical ascospore showing equatorial band and polar, boss-like thickening. X9360. c. *Gymnascella dankaliensis* (UAMH 3531). Oblique equatorial view of a typical ascospore showing irregular wall surface. X9360. d. *Gymnascella confluens* (UAMH 3565). Equatorial and polar views of typical smooth ascospores. X9360. e. *Gymnascella dankaliensis* (TRTC M7143). Ascospores with typical polar boss and equatorial thickening. X840. f. *Gymnascella dankaliensis* (TRTC M7143). More or less globose asci and several thick-walled hyphae associated with ascospores. X845.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Notes: Found most frequently in soil and materials of animal origin (mostly other than dung).

Material examined: UAMH 1665 (type strain as cited). O-288c (=UAMH 1777)/soil/Guatemala; O-1163 (=UAMH 3704, 3831)/rat dung/India; O-1177 (=UAMH 3525)/horn/India; O-1321 (=UAMH 3908)/soil/Italy; O-1505 (=UAMH 3592)/horse ringworm/Utah; O-2013 (=UAMH 3798)/soil/India; O-3212 (=UAMH 3766)/sputum/Kansas; O-3352 (=UAMH 1712)/soil/Guatemala; O-3473 (=UAMH 3656)/horse ringworm/Utah; O-3552 (=UAMH 3593)/foot lesion/Utah; O-3640 (=UAMH 3591)/contaminant/Utah; **UAMH** 3478/soil/Chile; 4152/beach sand/Italy; 4153, 4154/flower bed soil/Italy. **NY** O-1177/horn/India; O-1239/soil on horn/India; O-1299/pigeon feathers/Yugoslavia; O-2013/soil/India; O-2060/rodent/Arizona; O-2067/human lesion/California; O-3324/soil/Panama; O-3341, O-3359/soil/Italy; O-3442/soil/England; O-3454/duck feathers/Queensland; O-3629/soil/California; O-3719/soil/Italy.

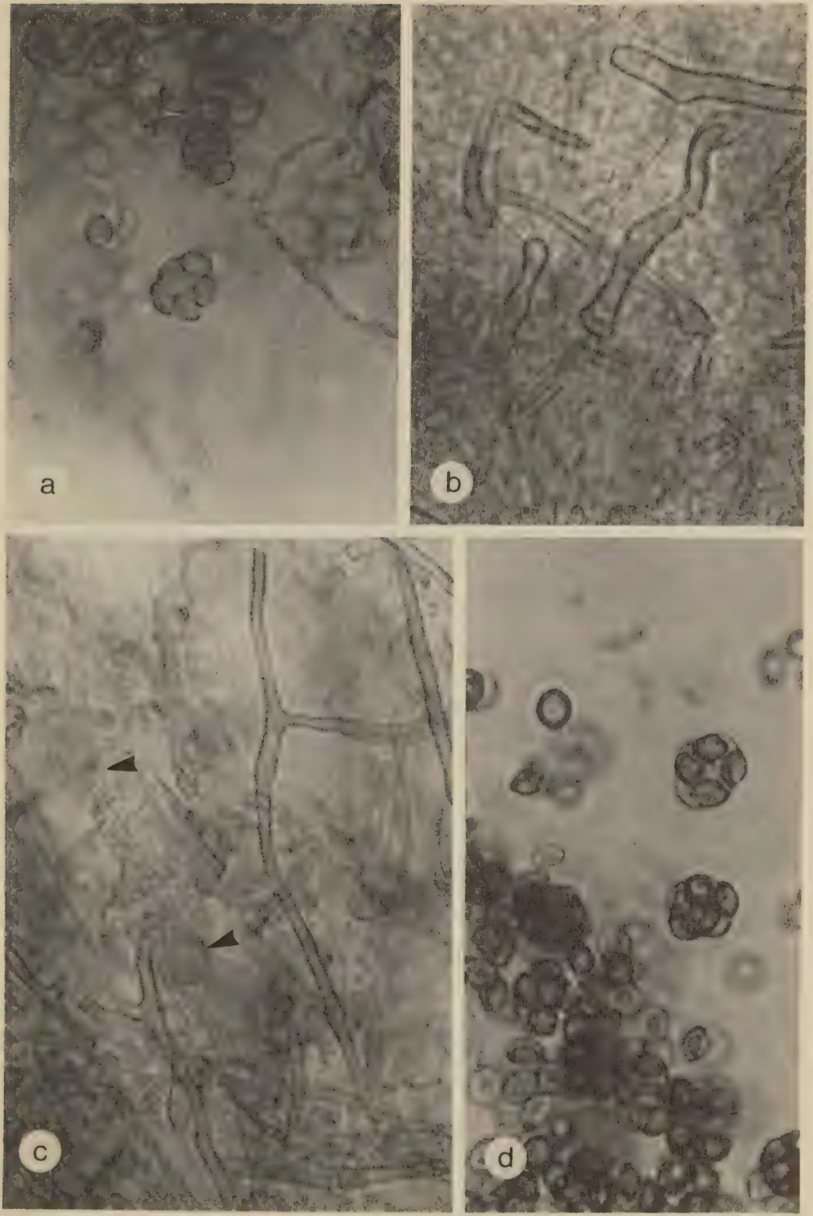
GYMNOASCUS Baranetzky, 1872
Botanische Zeitung **30**:158.

Type species: *Gymnoascus reessii* Baranetzky *op. cit.*

Ascomata: variable in color - pale yellow to brick-red or brown, sometimes green tinged, roughly globose, and often confluent, individual ascomata generally <1000*u*m. **Ascospores:** pale yellow, smooth, oblate, rim acute rather than flattened, approx. 4.5*u*m diam. **Asci:** ±globose, evanescent, 8-spored. **Peridial hyphae:** usually yellow to reddish brown, septate, thick-walled, conspicuously roughened. **Appendages:** when present, colored same as peridial hyphae, septate, thick-walled, coarsely roughened, branched. **Sexuality:** homothallic. **Anamorph:** lacking.

Notes: Orr recognized 5 species in 1977, including with the type: *G. dugwayensis*, *G. longitrichus*, *G. intermedius* and *G. uncinatus*. The latter species is here considered a species of *Uncinocarpus* (Onygenaceae) in recognition of its keratinolytic capacities, punctate ascospores and arthroconidial anamorph. The first two species, distinguished on the basis of appendage characteristics, are within the range of variability of *Gymnoascus reessii* and are considered here as facultative synonyms of that species. *Gymnoascus intermedius* is discussed below. In his concept of *Gymnoascus*, Von Arx (1981a) included *Gymnoascus*, *Gymnascella*, *Gymnoascoideus* (as "*Gymnoascoides*"), *Macronodus* (as *Gymnoascus bifurcatus*), *Neogymnomyces*, *Pectinotrichum*

Fig. 30. a. *Gymnascella marginospora* (ANSM QM 1327). Asci and ascospores with equatorial band. X1235. b. *Gymnascella marginospora* (ANSM QM 1327). Smooth, thick-walled hyphae associated with ascospores. X675. c. *Gymnascella marginospora* (ATCC buzzards stomach, C. L. Shear). Thick-walled hyphae associated with ascospores. Arrows indicate ampulliform swellings. X825. d. *Gymnascella punctata* (RSA 1544). Ascospores and asci. X1080.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and *Uncinocarpus*. Since his treatment of the genus lacks discussion it is not possible to begin to explain why such a broad generic concept was applied.

References: Apinis, 1964 (broad concept includes *Pseudogymnoascus*, *Auxarthron*, and *Gymnoascus*; a key to species is provided). Dale, 1903 (life history and developmental study of *Gymnoascus reessii*); Kuehn, 1956 (developmental morphology).

Gymnoascus intermedius Orr 1977 Mycotaxon 5:470-472, FIG 1-6.

Figs 23a,b 25d,e,f

Type material: HOLOTYPE (*cultura desiccata*) **NY** O-313 (soil, California).

Ascomata: yellow or yellow-green, ±globose, 75-470*u*m, mostly confluent, but sometimes discrete. **Ascospores:** yellow, smooth, oblate, 1.9-3 x 4-5*u*m. **Asci:** hyaline, ellipsoidal, 5.7-6 x 6-8.6*u*m. **Peridial hyphae:** smooth, straight, branched at right angles, anastomosing, 1.9-3.4*u*m, occasionally some elements swollen to 6*u*m. **In culture:** no cultures examined.

Material examined: as *Arachniotus lanatus*: **TRTC** 45468/dwelling/Ontario; as *Arachniotus* sp.: **RSA** 1443/lizard dung/Mexico; as *Gymnoascus intermedius* **FH**, **NY** O-104; O-291/soil/California; O-313/soil/California (type strain).

Notes: This species may be distinguished from *Gymnoascoideus petalosporus* by the absence of arthroconidia; also ascospores are not petaloid.

Gymnoascus reessii Baranetzky, 1872 Botanische Zeitung 30:158 Taf IIIA FIG 1-26.

Figs 1b 24a,b 32d

Type material: none.

=*Myxotrichum ochraceum* Berkeley and Broome, Grevillea 3:184 (see Massee and Salmon, 1902).

=*Myxotrichum coprogenum* Saccardo, Michelia 2:372, 1881, (see Massee and Salmon, 1902).

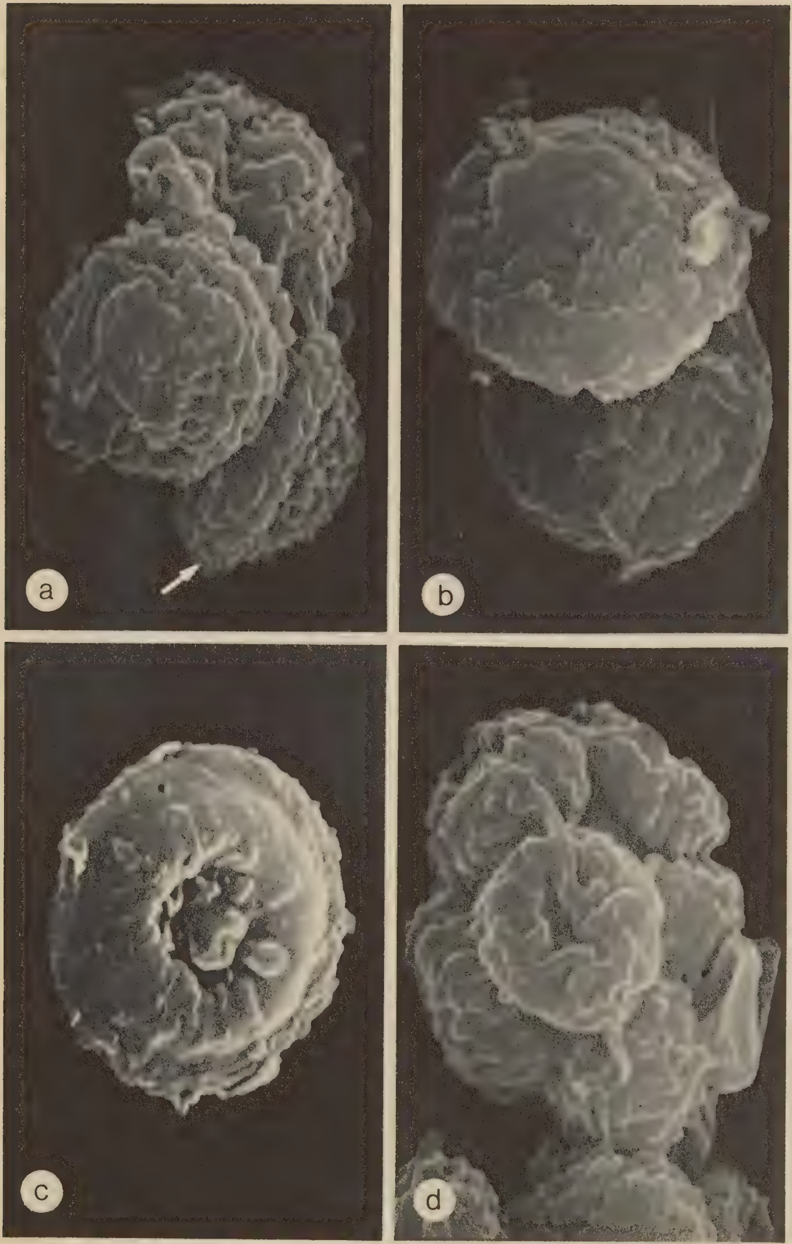
=*Gymnoascus dugwayensis* Orr and Kuehn, Mycologia 64:65, 1972.

=*Gymnoascus longitrichus* Orr and Kuehn *apud* Orr, Kuehn and Plunkett, Mycopathol. et Mycol. Appl. 21:9, 1963.

=*Gymnoascus corniculatus* Orr and Plunkett *apud* Orr *et al.*, *op. cit.*

Ascomata: yellow, red-brown or orange-brown, globose, confluent, 50-600*u*m diam. incl. appendages. **Ascospores:** yellow to reddish brown, smooth, 1.4-2.4 x 3.2-4*u*m, oblate.

Fig. 31. a. *Gymnascella marginospora* (UAMH 3164). Thick-walled ascospores with irregular or lumpy surface. Equatorial band indicated by arrow. X9750. b. *Gymnascella punctata* (UAMH 3530). Thick-walled, ±oblate ascospores with broad equatorial rims. X10080. c. *Gymnascella dankaliensis* (UAMH 3531). Oblique polar view of ascospore. X9360. d. *Gymnascella hyalinospora* (UAMH 3155). Conglobate, oblate ascospores with irregular walls. X9000.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Asci: subspherical to ovoid, 7.7-13*u*m diam. **Peridial hyphae:** red, yellow, green, brown, thick-walled, cuticularized, 2.2-4.4*u*m diam., smooth, or asperulate to coarsely rugose. **Appendages:** branched or unbranched. branches short, curved, blunt to subacute, apex hooked or bent, unequally bifurcate, curved "boat hooks" or trifurcate in "antlers." Some isolates with very long appendages to 500*u*m in length. **In culture:** [UAMH 1604]. CER 35/25°C ochre-yellow to olive green mounds on pinkish tan smooth mycelium; reverse yellow-brown. DSA 32/25°C orange-brown, discrete knots scant; reverse hyaline or concolorous. PYE 21/25°C brownish yellow to cream with greenish tinge in central area; reverse yellowish green.

Notes: This largely coprophilous species is extremely common, especially on herbivore dung (horse, rabbit and sheep), and displays a wide range of variability in color and morphology of the peridial hyphae and appendages (Orr, Kuehn and Plunkett, 1963d). It is cosmopolitan in distribution and in addition to its coprophilous habit it has been found in soils of various types (see Domsch, Gams and Anderson (1980)) as well as in decaying vegetable matter (Udagawa, 1963). Additional detailed descriptions can be found in Benjamin (1956), and Domsch, Gams and Anderson (1980).

Material examined: as *Gymnoascus corniculatus*: **RSA** 1548/substrate?/California; **TRTC** C1623/porcupine dung/Ontario; **UAMH** 3159 (=RSA 1549)/soil/California; as *Gymnoascus reessii*: **BP** 53884, 53885/deer dung/Hungary; **DAOM** 124076/rat dung/Kansas; **E** Watling 8182/cat dung/Scotland; 1200/lab contaminant/Scotland; ?/toilet/Scotland; **FH** O-146 (=UAMH 1606) (Not typical); O-217; **NY** rat dung/? (*Gymnoascus coprogenum*); as *Gymnoascus reessii*: **RSA** 404/coyote dung/California; 61/rat dung/Massachusetts; 1259/lizard dung/California; 2506/mouse dung/California; 201/dung/California; **S** G; Winter/sheep dung/Germany?; **TRTC** 66;1738j/elephant dung/Tanzania; 66.3276/elephant dung/Kenya; 6511/finch dung/Germany; 6844/fowl dung/India; 6521/roe dung/Germany; 34654/fox dung/Ontario; 12187/goose dung/Quebec; (FH, NY) 6509/hare dung/Germany; 6842/rat dung/India; 17870/antelope dung/Tanzania CBS-Clausen; 32269/porcupine dung/Wyoming; 66.1440/herbivore dung/Kenya; 66.3111/herbivore dung/Tanzania; **UAMH** 1604/pack rat dung/California from Orr as O-146 (1960); 3140 (=RSA 1485)/lizard Dung/Mexico; 2488/hand scraping/Alberta; UAMH 4809/coyote dung/Alberta, coll; Currah; **UPS** Santesson

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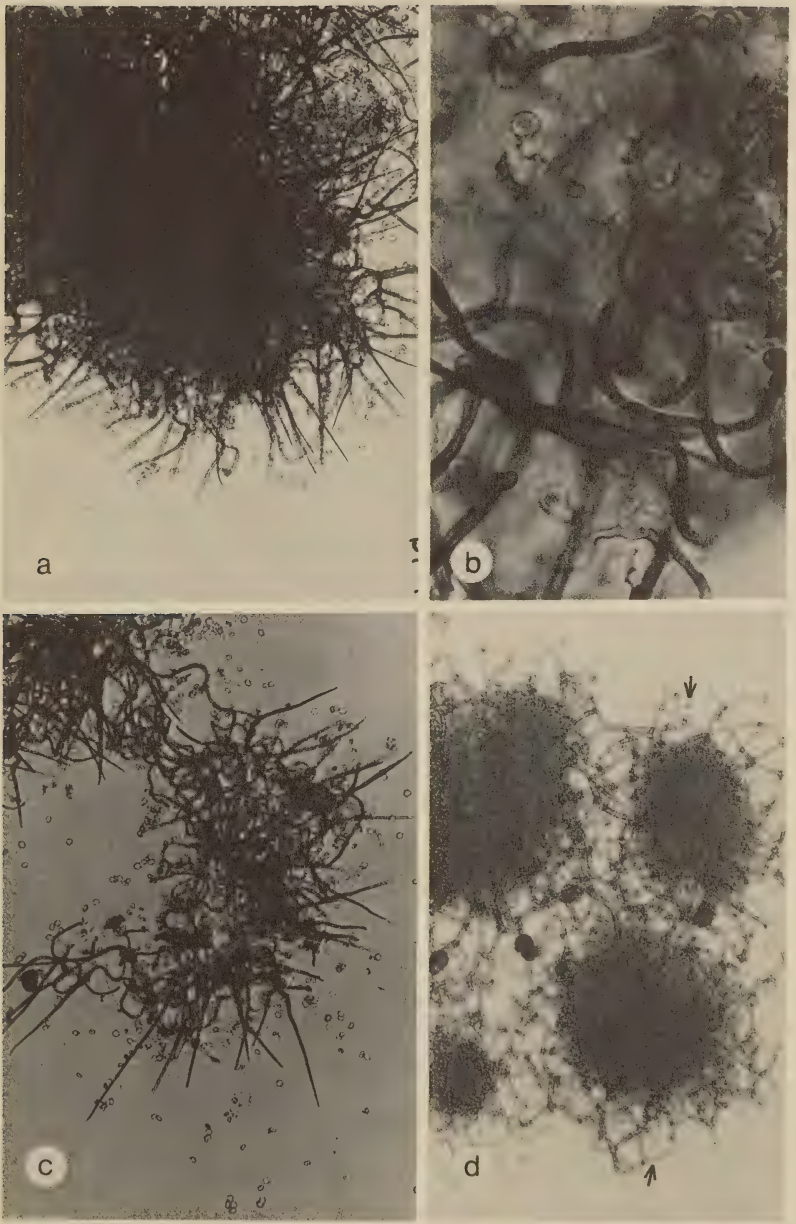
Fig. 32. a. *Acitheca purpurea* (FH Holotype). Ascoma from type specimen with needle-like appendages. X160. b. *Acitheca purpurea* (FH Holotype). Smooth, oblate ascospores and curved, proximal portions of needle-like appendages. X750. c. *Acitheca purpurea* (FH Holotype). Organization of peridial hyphae and appendages. X230. d. *Gymnoascus reessii* (from coyote dung coll. UADBG, 1980). Four individual ascomata with boat-hook appendages indicated by arrows. X180.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12350/roe dung/Sweden; as *Gymnoascus ruber*: **MICH** Povah 177/dung/Michigan; **NY** O-146; O-2605/clay soil/Utah; Martin 6466/deer dung/California; Rogerson 36-1/dung/Utah; **DAOM** 122144 (=Thaxter 1925)/dog dung; **FH** ?/dog dung/Argentina (with *Arachniotus ruber*); as *Gymnoascus zuffianus*: **UPS** Lundqvist 5647-r/sheep dung/Libya; as *Myxotrichum coprogenum*: **BR** Bommer and Rousseau/mouse dung/France.

SPECIES EXCLUDED OR REFERRED TO OTHER GENERA

Gymnoascus aurantiacus (Peck) Saccardo, Sylloge Fungorum 8:823
≡*Gymnascella aurantiaca*.

Gymnoascus aureus Eidam, Ber. Bot. Sect. Schles. Ges. **64**:161, 1887
≡*Amauroascus aureus* (Onygenaceae).

Gymnoascus brevisetosus Kuehn, Mycologia **48**:813, 1956
=*Auxarthron zuffianum* (Onygenaceae).

Gymnoascus californiensis (Orr and Kuehn) Apinis, Mycol. Pap. **96**:12, 1964
≡*Auxarthron californiense* (Onygenaceae).

Gymnoascus confluens Sartory and Bainier, Bull. Soc. Mycol. Fr. **29**:261, 1913
≡*Gymnascella confluens*

Gymnoascus corniculatus Orr and Plunkett, Mycopathol. et Mycol. Appl. **21**:1, 1963
=*Gymnoascus reessii*

Gymnoascus demonbreunii Ajello and Cheng, Mycologia **59**:682, 1967
≡*Neogymnomyces demonbreunii* (Onygenaceae).

Gymnoascus dugwayensis Orr and Kuehn
=*Gymnoascus reessii*.

Gymnoascus durus Zukal, Ber. dtsch. bot. Ges. 8:259, 1890
≡*Keratinophyton durum* (Onygenaceae).

Gymnoascus eidami Cocconi, Mem. R. Acad. Sci. Bologna V 2: 32, 1891
=*Auxarthron zuffianum* (Morini) Orr and Kuehn *fide* Orr and Kuehn and Plunkett, 1963.

Gymnoascus flavus Klocker, Nova Hedwigia **41**:80, 1902.
≡*Talaromyces flavus* var. *flavus* Stolk and Samson, CBS Stud. Mycol. **2**:11, 1972 (Eurotiales).

Gymnoascus gypseus Nannizzi, Atti. R. Acad. Fis. Siena 2: 94, 1927
≡*Nannizzia gypsea* (Arthrodermataceae).

Gymnoascus johnstoni (Massee and Salmon) Orr and Kuehn, Mycopathol. et Mycol. Appl. **21**:8, 1963
(*Species incertis est*.)

Gymnoascus longitrichus Orr and Kuehn
=*Gymnoascus reessii*.

Gymnoascus luteus Saccardo, Sylloge Fungorum **11**:437, 1895
≡*Talaromyces luteus* (Saccardo) Stolk and Samson 1972 (Eurotiales).

Gymnoascus myriosporus Rostrup, Med. om Groenland **18**:12, 1894.
≡*Myrillium myriosporus* (Rostrup) Clements see Clements and Shear, 1931.

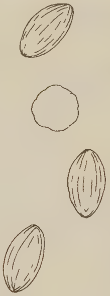
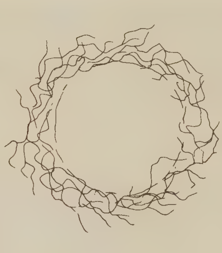
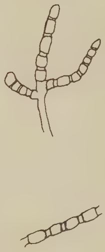
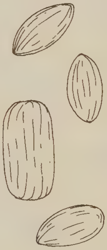
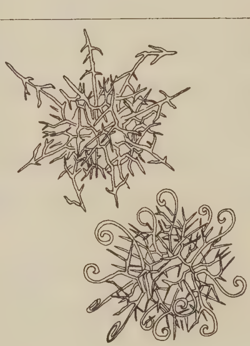
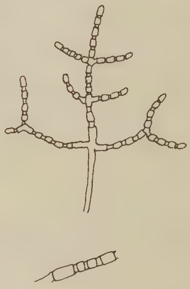
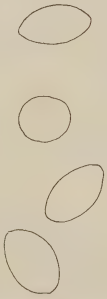
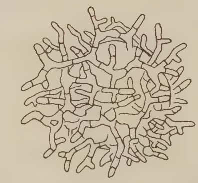
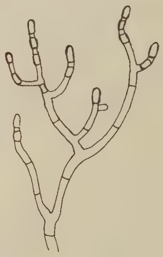
Gymnoascus ossicola Rostrup, Bot. Tidsk. 21:45, 1897
≡*Nannizzia ossicola* (Arthrodermataceae).
Gymnoascus petalosporus (Orr, Roy and Ghosh) Von Arx, 1977
≡*Gymnoascoideus petalosporus*.
Gymnoascus racovitzae Lagarde Arch. Zool. exp. gen. 53:281, 1913
≡*Kuehniella racovitzae* (Onygenaceae).
Gymnoascus reticulatus Zukal Verh. Zool.-Bot. Ges. Wien 37:40, 1887
≡*Auxarthron reticulatum* (Onygenaceae).
Gymnoascus rhousiogongylinus Wener and Cain, Can. J. Bot. 48:325, 1970
=*Pseudogymnoascus roseus* (Myxotrichaceae).
Gymnoascus ruber Van Tieghem, Bull. Soc. Bot. Fr. 24:159, 1877
≡*Arachniotus ruber*.
Gymnoascus setosus Eidam, Bot. Cent. 10 :107, 1882
≡*Myxotrichum setosum* (Myxotrichaceae).
Gymnoascus siglerae The genera of fungi sporulating in pure culture Von Arx, 3rd Edition. p132, 1981
≡*Uncinocarpus reesii* (Onygenaceae).
Gymnoascus stipitatus Lindfors, Svensk. Bot. Tidskr. 14:270, 1920
≡*Myxotrichum stipitatum* (Myxotrichaceae).
Gymnoascus subumbrinus Smith, Trans. Brit. mycol. Soc. 5:424, 1917
=*Auxarthron umbrinum* (Onygenaceae).
Gymnoascus sudans Valionis, Vyt. Didziojo Mat. Gamtos Fak. Darbei 11:115, 1936
=*Byssochlamys nivea* Westling (Eurotiales, See Stolk and Samson, 1971).
Gymnoascus umbrinus Boudier, Bull. Soc. Mycol. Fr. 8:43, 1892
≡*Auxarthron umbrinum* (Onygenaceae).
Gymnoascus verrucosus Eidam, Jber. Schles. Ges. vaterl. Kult. 64:162, 1887
=*Amauroascus mutatus* (Onygenaceae).
Gymnoascus verticillatus A. L. Smith, Trans. Brit. mycol. Soc. 1:154, 1896
see discussion on *Oncocladium flavum* (Onygenaceae).
Gymnoascus vinaceus (Raillo) Apinis, Mycol. Pap. 96:9, 1964
=*Pseudogymnoascus roseus* (Myxotrichaceae).
Gymnoascus zuffianus Morini, Mem. R. Acad. Sci. Bolgna V 2:32, 1891
≡*Auxarthron zuffianum* (Onygenaceae).

MYXOTRICHACEAE

Myxotrichaceae Locquin ex Currah
Typus: Myxotrichum Kunze.

Ascocarpi ruber, aut rosei, aut virelli-brunnei (plerumque apparenter anthracini); ±globosi. Ascosporae hyalinae ad gilvae aut roseae, late ellipticae aut fusiformae, levae aut cum striis. Asci globosi aut subglobosi. Hyphae peridii lutea, rosea aut roseobrunnea, crasso-parietales, levae aut asperulatae, septatae ramosae. Appendicula destitutae, aut

TABLE 13 GENERA OF MYXOTRICHACEAE

Genus	Ascospores	Peridia and Appendages	Anamorphs
Byssoascus			
Myxotrichum			
Pseudogymnoascus			

brevae aut elongatae; lutea, rosea aut roseobrunnea, crasso-parietales, levae aut asperulatae, septatae ramosae; acutae aut obtusae, rectae aut unciformae. Homothallicus. Stat. conid: Geomyces, Oidiodendron et conidia alternatae sine nomine.

Ascomata: rose or deep reddish or greenish brown (often appearing black), ±globose reticuloperidium (absent in one genus) of asperulate, septate hyphae. **Ascospores:** hyaline to pale yellow or rose, ellipsoid or fusoid, smooth or long-striate, rather thin-walled, <6*u*m long, (one species with ascospores as long as 14*u*m). **Asci:** hyaline, globose or subglobose, diam. rarely greater than 12*u*m (one species to 20*u*m). **Peridial hyphae:** yellow, rose or reddish brown, thick-walled, smooth or asperulate, septate, branched, often terminating in "witches' brooms" of short acutely pointed branches. Peridium absent in one genus. **Appendages:** present or lacking, pigmented, forming long croziers or hooks, or consisting of long or short, ±straight, pointed or blunt ends of peridial hyphae. **Sexuality:** homothallic. **Anamorphs:** *Geomyces*, *Oidiodendron*, *Malbranchea* and unnamed arthroconidial anamorphs.

Notes: Locquin (1974) proposed the family Myxotrichaceae but did not validly publish the name (Eriksson, 1982). Von Arx (1981b) suggested that a new family might be appropriate for *Myxotrichum* and its allies. The Myxotrichaceae here includes the cellulolytic Onygenales. These species are distributed among three genera: *Byssoascus*, *Myxotrichum*, and *Pseudogymnoascus* (Table 13). They form what appears to be a homogeneous group based on their cellulolytic capacities, ascospore morphology and anamorph characteristics.

Peridial morphology varies from telaperidia in *Byssoascus* to elaborate and appendaged reticulothecia in *Myxotrichum*. No membranous forms are known although a collection at DAOM (176970a, coll. George White, rotting conifer log, Waterton National Park) appears to represent a new genus of the Myxotrichaceae with a membranous peridium. Ascospores are characteristic of the family (fusoid, striate, yellow, 1.6-2.1 x 3.9-4.5*u*m). These are borne in an easily-ruptured, membranous cleistoperidium. An *Oidiodendron* state was cultured from the substrate but its relationship to the ascospores has so far not been determined. A detailed report must await further study of the material.

Although *Pseudogymnoascus* is frequently found during studies of the mycota of higher plant rhizospheres, most species in the family are rarely encountered. Habitat and cultural evidence suggests that the Myxotrichaceae may be a psychrophilic group (optimum temperature <18°C). Although one or two isolations have been obtained from animal sources (fingernail, dog lesion), there is no evidence that any of these taxa are pathogenic.

BYSSOASCUS Von Arx, 1977
Persoonia 6:377.

Type species: *Byssoascus striatosporus* (Barron and Booth) Von Arx *op. cit.*

Ascomata: white, globose. **Ascospores:** hyaline to pale yellow, fusiform, striate. **Asci:** ovoid. **Peridial hyphae:** hyaline, thin-walled, apparently undifferentiated. **Appendages:** lacking. **Anamorph:** alternate arthroconidia.

Byssoascus striatosporus (Barron and Booth) von Arx, 1971 Persoonia **6**:377.
Type material: HOLOTYPE (*cultura desiccata*) **CMI** 115998 (soil, Ontario).
≡*Arachniotus striatosporus* Barron and Booth, Can. J. Bot. **44**:1060, 1966 (Basionym).
≡*Myxotrichum striatosporum* (Barron and Booth) Sigler, Mycotaxon **4**:385, 1976.
Anamorph name: *Oidiodendron*, *fide* Sigler and Carmichael, 1976.

Ascomata: white, cottony telaperidium, often confluent, 100-200um diam. (*fide* Barron, *op. cit.*); ±fascicular bundles of thick-walled, dark hyphae form in culture *fide* Sigler and Carmichael (1976). **Ascospores:** greenish yellow, fusiform, striate, 1.5-3 x 4.5-6.5um. **Asci:** ovoid to clavate. **Peridial hyphae:** hyaline, mostly undifferentiated from vegetative hyphae. Some brown, thick-walled, smooth, branched hyphae present. **Anamorph:** arthroconidia olive-green, slightly asperulate, barrel-shaped, 1.5-2.5 x 1.5-3.5um, borne on narrow, hyaline conidiophores or on apparently undifferentiated hyphae. **In culture:** [UAMH 3572]. CER 42/25°C olive-green, slightly zonate, margin yellow; reverse light brown. DSA 42/25°C pale cream-colored, scant. PYE 35/25°C abundant green-gray growth, mat puckered and heaped; reverse dark reddish brown.

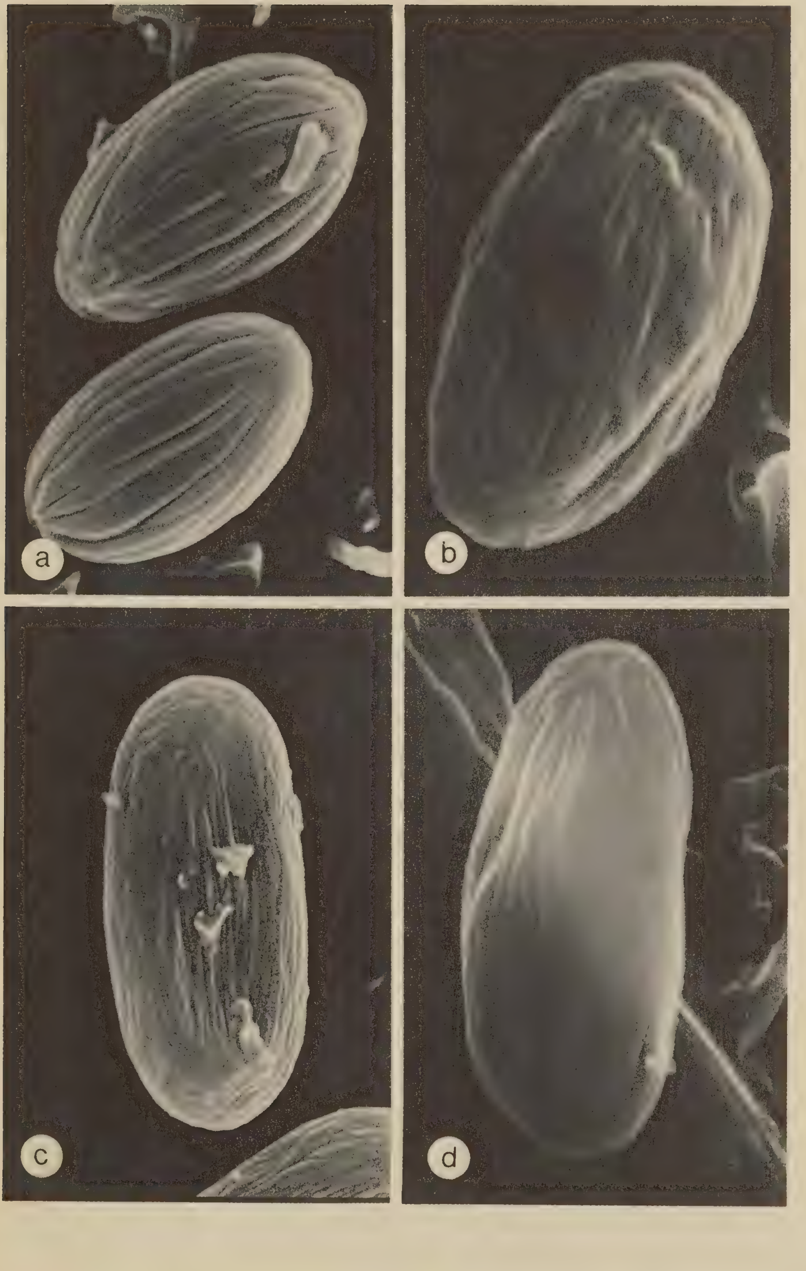
Notes: Barron and Booth (1966) do not mention the dark, thick-walled peridial elements (observed by Sigler and Carmichael, 1976), in their original description of this species. The *Oidiodendron* anamorph, yellow, striate, fusoid ascospores and the ability to break down cellulose, place this species in the Myxotrichaceae. The peridium is the distinction at the genus level. Known only from the type.

Material examined: UAMH 3572 (type strain as cited, obtained from CBS).

MYXOTRICHUM Kunze, 1823
Mykol. Hefte **2**:109.

Type species: *Myxotrichum chartarum* (Nees) Kunze.
=*Campsotrichum* Ehrenberg, 1819. (non Necker, 1770 and *nomen invalidum fide* Hughes, 1968).
≡*Actinospira* Corda, 1854.

Fig 33. a. *Myxotrichum chartarum* (BR Zahlbruckner 3180). Fusiform ascospores with pronounced, longitudinal striae. X10080. b. *Myxotrichum stipitatum* (UAMH 3165). Ascospore with faint longitudinal striae. X18720. c. *Myxotrichum bicolor* (LE NR26/511). Ascospore with broadly rounded ends and regular, faint, longitudinal striae X5580. d. *Myxotrichum aeruginosum* (UAMH 3086). Longitudinally striate ascospore. X12960.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=*Eidamella* Matruchot and Dassonville, 1901.
?=*Tripedotrichum* Orr and Kuehn, 1964a.
=*Toxotrichum* Orr and Kuehn, 1964b.

Ascomata: dark reddish or greenish brown to almost black, ±globose, often confluent, especially on natural substrata. **Ascospores:** hyaline to pale yellow, ellipsoid or fusoid, often with one end broader than the other, thin-walled, longitudinally striate. Striae few to numerous, pronounced or barely discernible. **Asci:** hyaline, ±globose. **Peridial hyphae:** reddish brown, thick-walled, cuticularized (shiny), usually richly branched and sometimes anastomosed, always forming a reticuloperidium. **Appendages:** septate, elongate, straight or curved, simple or branched, tips straight, bent, curved or uncinate, ±branchlets. **Anamorph:** aleurioconidia and arthroconidia; some assignable to *Malbranchea* and *Oidiodendron*.

Notes: Nees (1823) first described *M. chartarum* in a new genus which he called *Oncidium*, a name which was already occupied in the Orchidaceae. Kunze (1823) renamed the genus *Myxotrichum* and it then became a repository for everything from a variety of dematiaceous hyphomycetes to reticuloperidial ascomycetes with hooked appendages (Schroeter, 1893). Kuehn (1956) and Orr, Kuehn and Plunkett (1963c) give comprehensive historical accounts of the genus. The genus is still poorly understood, due in part to the paucity of isolations available. Orr, Kuehn and Plunkett *op. cit.* monographed the genus and Orr and Kuehn (1964 a,b) later described the apparently related genera, *Toxotrichum* and *Tripedotrichum*. *Tripedotrichum* was described as a *Myxotrichum*-like genus with brown, oblate ascospores. I have examined the type material and I suspect that Orr and Kuehn mistook the dematiaceous conidia of a hyphomycete (possibly *Stephanosporium cereale*) for ascospores. Further comments on this name should await the availability of cultures of the fungus producing the interesting tripod-shaped appendages (setae?). Von Arx felt this taxon represented a *Gymnoascus* species since the "appendages" were similar to *Gymnoascus uncinatus* and to *Uncinocarpus reesii*. *Toxotrichum* was erected for *Myxotrichum cancellatum*, since unlike other *Myxotrichum* species, peridial hyphae were roughened and lacked free apices. There is no need to keep this species in a separate genus. The nature of the reticuloperidium and the color and morphology of the ascospores place it well within the concept of the genus *Myxotrichum*.

Apinis (1964) arranged the species of *Myxotrichum* among four subgenera: *Eidamella*, *Myxotrichum*, *Pseudomyxotrichum*, and *Tripedotrichum* to recognize variation in appendages.

Some dematiaceous hyphomycetes bear setae which are strikingly similar to elements of *Myxotrichum* reticuloperidia (e.g. *Gyrothrix podosperma* see PL 34f).

Myxotrichum aeruginosum Montagne, 1836 Ann. Sci. Nat. Bot. II 6:30.

33d 35f

Type material: HOLOTYPE (natural material). K "ex Montagne" (cardboard, France).

Ascomata: dark brown to black, spherical, 170-350μm diam., excl. appendages. **Ascospores:** pale yellow with a faint greenish cast, smooth, ovoid, ellipsoid to fusoid 1.6-3 x 3-5.5*u*m. **Asci:** hyaline, subglobose to ellipsoid, 8-10*u*m. **Peridial hyphae:** dark brown to almost black, branched, thick-walled, ending in a few elongate appendages; numerous, short, awl-shaped spines, 30-65*u*m with branches at 60° angles at base of appendages. **Appendages:** dark brown, fading and tapering toward apex, up to 7-8-septate, straight, bent, apically uncinate (but not enlarged), 70-250*u*m in length, 3.8*u*m wide at base. **Anamorph:** some arthroconidia recorded. **In culture:** [no cultures].

Notes: *Myxotrichum aeruginosum* and *Myxotrichum ochraceum* have been frequently confused. An historical account of the problems in distinguishing between these two species is provided by Orr, Kuehn and Plunkett (1963c). Unfortunately, they also confused the species by calling Roumeguere 7366 "*Myxotrichum ochraceum*" when it is actually a fine example of *M. aeruginosum*. The two species are also confused with *Myxotrichum stipitatum* which in turn is close to *Myxotrichum setosum*. An adequate treatment of the taxonomy of these species must await further isolations, since *M. aeruginosum* is known only from dried material.

Material examined: as *Myxotrichum aeruginosum*: **BR** ?/burlap sacking?/?; **DAOM** 50964 (ex Uppsala)/rotten cloth/Sweden?; 49096/sacking/Strasbourg?.

Myxotrichum berkeleyi Apinis, 1964 Mycol. Pap. **96**:17-19, FIG 2a-d.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** 57211 (pine deck planking, Britain).

Ascomata: brown to black, single, clustered, 150-300*u*m excl. appendages. **Ascospores:** pale yellow (hyaline), smooth or finely striate, 1.5-2.5 x 3.2-4.5*u*m. **Asci:** subglobose to ovoid, 6.9*u*m diam. **Peridial hyphae:** brown, septate, smooth, branched, loosely interwoven. **Appendages:** brown, ±striate, 2-6*u*m wide and 200-450*u*m in length, basal branches deflexed. **Anamorph:** aleurioconidia present in type strain (UAMH 1658). **In culture:** [UAMH 1658]. CER 38/25°C white to gray, felty; reverse yellow-orange. DSA 54/25°C ring of orange-brown mycelium surrounded by cloudy growth. PYE 28/25°C fuzzy, felt-like, yellowish orange to gray, slightly granular; reverse orange brown.

Notes: The type strain has failed to fruit at UAMH and the above description is largely taken from the original.

Material examined: **UAMH** 1658 from Orr as O-2513 (1963). (O-2513 also applied by Orr to a collection of *Pseudogymnoascus roseus*).

Myxotrichum bicolor (Ehrenberg) Fries, 1832 Systema Mycologicum **3**:351.

Figs 33c 34b 35d

Type material: HOLOTYPE (natural material) **L** ex Herb. Persoon (*Usnea plicata*, Germany).

≡*Campsotrichum bicolor* Ehrenberg, Hor. Phys. Ber. 32, 1820 and Link's Jahrb. Gewachsk. II 1:32, 1819. (Basionym).

=*Myxotrichum poluninii* Apinis, Mycol. Pap. **96**:26, 1964.

Ascomata: dark grayish brown to black, gregarious to confluent, on lichen thalli, individual ascospore clusters 50-800um diam. **Ascospores:** hyaline to yellow-brown, ellipsoidal, ends broad or flattened, 3-6 x 8-14um. **Asci:** irregular to mostly obovoid, 10-14 x 14-19um. **Peridial hyphae:** (No distinction can be made between peridial hyphae and appendages). Peridial hyphae and appendages brown, smooth, branched, septate, 1.5-5.5um diam., proximal portion with delicate witches' brooms; distal portion becoming greater in diam., septate or aseptate, with curved to uncinate lateral branches. **Anamorph:** unknown. **In culture:** no known cultures.

Notes: Apinis (1964) described *Myxotrichum poluninii* based on material on a collection of *Cetraria* from Akpatok Island, Canada. Hughes' (1968) study of the type provides a good summary of the nomenclature of the species and gives photographs of the holotype. This taxon is listed by Vouaux (1914) and Keissler (1930) as a *Myxotrichum* on lichens. Apparently a lichenicolous member of the Myxotrichaceae, and probably represents a new genus, due to its habitat and large blunt-ended ascospores.

Material examined: DAOM 49089/lichen/?; 50164, 50173 ex Persoon/Leiden?; **LE** ex Herb; Chamisso/lichen/?; as *Gymnoascus* sp.: N26/511/lichen/USSR.

Myxotrichum cancellatum Phillips, 1884 Grevillea 13:51-52. 34c

Type material: HOLOTYPE (natural material) **K** Herb. William Phillips (stem of *Bartsia odonites*, Britain).

=*Myxotrichum spinosum* Massee and Salmon, Ann. Bot. **16**:64, 1902.

≡*Toxotrichum cancellatum* (Phillips) Orr and Kuehn, Mycologia **63**:191-203, 1964b.

Ascomata: brown, globose, 100-350um diam. **Ascospores:** hyaline, ellipsoidal, smooth, 1-2 x 3-4um. **Asci:** globose to subglobose, 4-6 x 5-7um. **Peridial hyphae:** dark brown, minutely asperulate, 2.5-5.5um diam. **Appendages:** dark brown, radiating spines, to 350um long, smooth, 3-5um at base, 1-2 septate, tapering toward apex, arising from arched asperulate hyphae of the peridium. **Anamorph:** arthroconidia olive brown, smooth, 2-2.5 x 2.5-3.5um. **In culture:** [UAMH 1996]. CER 14/25°C dark, grayish brown, felty; reverse with

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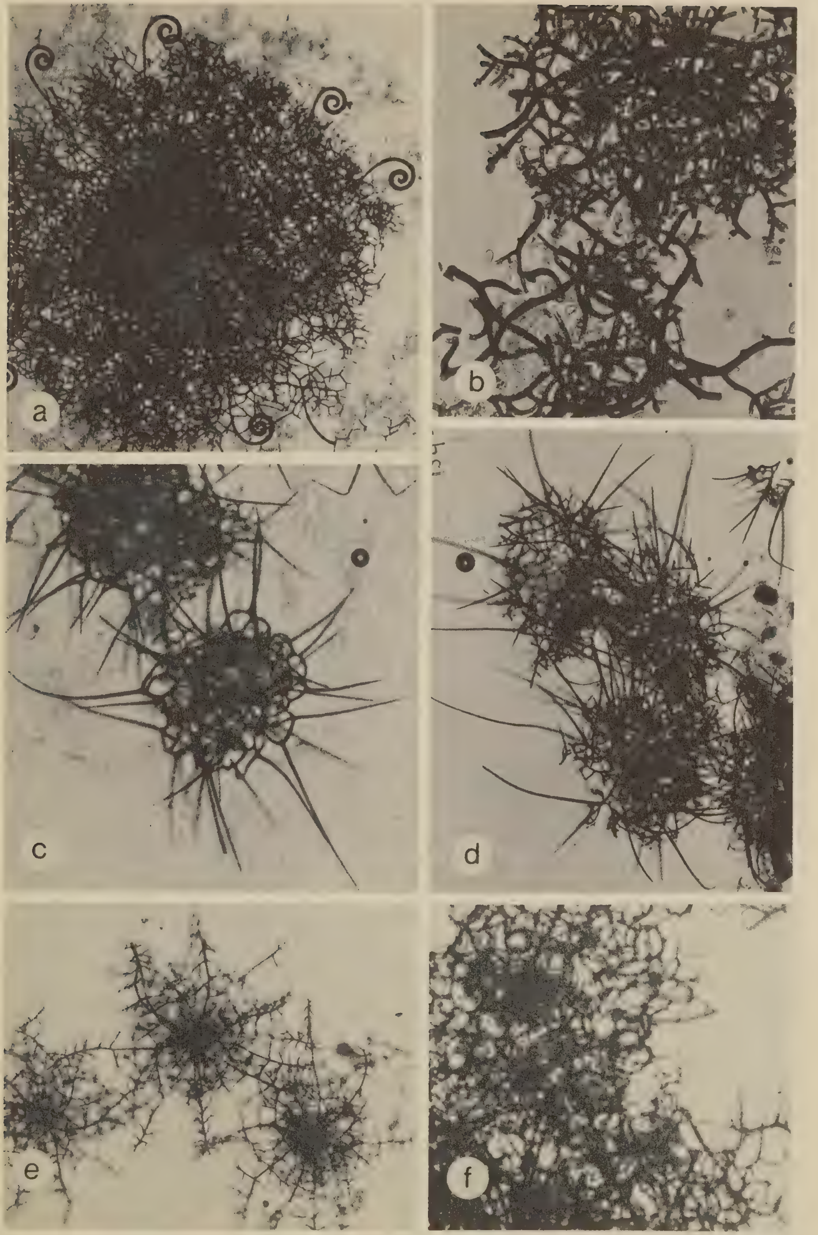
Fig 34. a. *Myxotrichum chartarum* (DAOM 49095). Richly branched reticuloperidium with uncinate appendages. X120. b. *Myxotrichum bicolor* (LE NR26/511). Thick-walled, recurving peridial hyphae from confluent mass of ascomata. X215. c. *Myxotrichum cancellatum* (OSC 7282). Ascoma with long, radiating, spine-like appendages arising from the arches of the peridium. X145. d. *Myxotrichum ochraceum* (RSA 1190). Ascoma with long, tapering appendages branched at base. X145. e. *Myxotrichum deflexum* (RSA 203). Ascomata with long, monopodially branched appendages. Apices acute. Side branches deflexed. X10. f. *Gyrothrix podosperma* (LE 1866). Setae of this hyphomycete resemble the peridial hyphae of *Myxotrichum bicolor*. X85.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pale rose hue. DSA 42/25°C dark, grayish or olive-colored with darker perimeter, halo of white (gray speckled mycelium). PYE 28/25°C grayish charcoal; reverse brownish red.

Notes: Udagawa (1963) studied this species in culture and noted gametangial morphology. Orr and Kuehn (1964b) based their genus *Toxotrichum* on this species. They considered the straight appendages, and lack of free apices on the peridial hyphae, distinctive characters at the genus level.

Material examined: **RSA** 1248 (=UAMH 1911) blueberry pastry/New Jersey; **NY** O-1963, K-1965, K-1983/blueberrry pastry/New Jersey; as *Eidamella spinosa*: **TRTC** Date 1957/?/?; as *Gymnoascus* sp.: **TRTC** 39451/rodent dung/Alberta; as *Myxotrichum spinosum*: **OSC** 7282/hog dung/Massachusetts.

Myxotrichum chartarum (Nees) Kunze, 1823 Mykol. Hefte **2**:110. 33a, 34a, 35c,e

Type material: NEOTYPE (*cultura desiccata*) **RSA** 55 (rotting board, Massachusetts). (Designated Orr *et al.* 1963c).

≡*Oncidium chartarum* Nees, Mykol. Hefte **2**:63, 1823 (Basionym).

≡*Actinospira chartarum* (Nees) Corda, Icones Fungorum **6**:7, 1854.

=?*Dematium olivaceum* Schumacher, Enum. pl. Saell **II**:445, 1803 (?*fide* Orr *et al.*, *op. cit.*, see notes below)

=*Myxotrichum carminoparum* Robak, Naturvidensk. 71:201, 1932.

Ascomata: greenish-gray, brown, black, globose, 150-600μm excluding appendages. **Ascospores:** pale yellow to orange yellow, 2-2.5 x 4-4.5, broadly fusoid, with prominent longitudinal striations. **Asci:** hyaline, ellipsoid, 5-7 x 6-8μm. **Peridial hyphae:** dark brown to almost black, profusely branched (sometimes dichotomously), smooth, thick-walled, shiny, 1.7-3.3μm thick and ending in numerous spines. **Appendages:** dark brown, shiny, rigid, elongate, uncinate, septate, 50-180μm long, 2.3-3.3μm diam. at base, enlarging to 4.5-6.4μm diam. at apex. Apices subacute or rounded. **Anamorph:** aleurioconidia and arthroconidia, solitary or in chains, 1.3-3.3 x 3.2-8μm. **In culture:** [UAMH 1598]. CER 28/25°C felty, tan yellow, rippled, convoluted, restricted growth; reverse purplish yellow. DSA 28/25°C yellowish, felty with peppering of black ascomata; reverse yellowish orange. PYE 28/25°C convoluted, wrinkled, reddish

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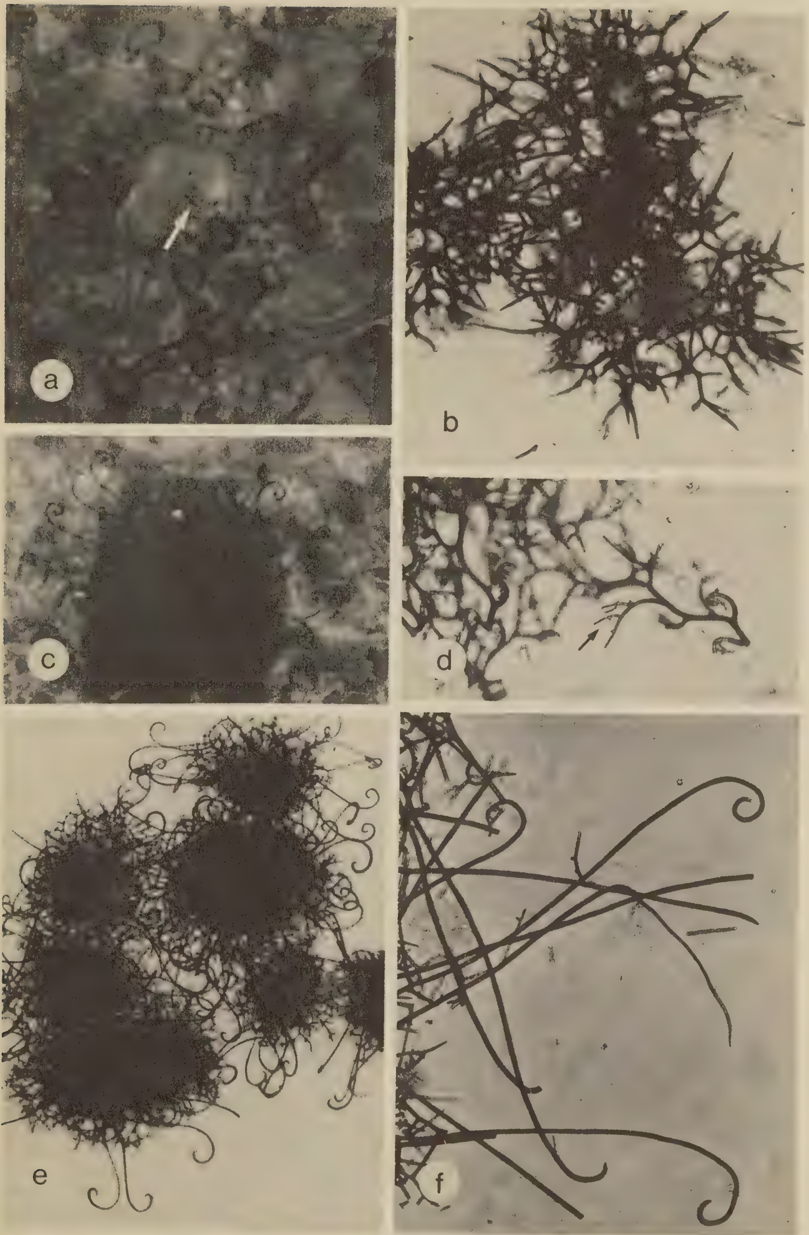
Fig. 35. a. *Pseudogymnoascus roseus* (RSA 1966). Coarsely asperulate appendage. X720. b. *Myxotrichum stipitatum* (RSA 1556). Three interlocked ascomata with typical sharp-spined, peridial hyphae/appendages. X180. c. *Myxotrichum chartarum* (PAV 192). Habit on paper. X70. d. *Myxotrichum bicolor* (LE NR26/511). Element of the peridium. Arrow indicates -witches broom- at proximal end of element. X180. e. *Myxotrichum chartarum* (PAV 192). Uncinate appendages slightly longer and less tightly coiled than those of DAOM 49095 (Fig. 34a). X72. f. *Myxotrichum aeruginosum* (DAOM 50964). Elongate, uncinate appendages. X215.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brown with white overgrowth; some black tinged heaped areas; reverse yellow.

Notes: Hughes (1968) presents an interesting discussion of some *Myxotrichum* synonyms listed by Fries. He does not discuss the synonyms in Orr *et al.* Regarding *Dematium olivaceum*, Orr *et al.* do not mention why it is a synonym, or if the type had been examined. From Schumacher's description, *D. olivaceum* could be a dematiaceous hyphomycete. Further comment on this name must await an examination of the type material.

Myxotrichum chartarum produces a beautiful ascoma with striking uncinate appendages. It would be of interest to know the range of variability of these appendages and of the species in general. Orr *et al.* observed that the uncinate appendages were flattened at the distal end causing them to appear wider. *M. chartarum* is a slow-growing species intolerant of high temperatures. This species grows well (but slowly) at temperatues as low as 5-7°C, and produces a diffusible red-brown pigment on some media. Robak (1932) described *Myxotrichum carminoparum* (Robak, Naturvidensk. 71:201, 1932 FIG 1-3) as a species smaller than *M. chartarum* and differing in producing a red pigment on artificial media. His collection also had circinate appendages but these lacked the characteristic swellings in the apical region such as are found in *Myxotrichum chartarum*. In all other respects the isolate was identical to the type of *Myxotrichum*. The type strain of *M. carminoparum* (from wood pulp, Norway) has not fruited in UAMH. However, I do not feel the reported differences merit its retention as a separate species. Orr reports that this species does not grow at 37°C but will grow at +7 or -2 °C. A somewhat intermediate form was reported by Udagawa (1963). His collection resembled *Myxotrichum carminoparum* in its small size of the ascomata but because it had "inflated circinate" appendages, he placed it in *Myxotrichum chartarum*.

Material examined: AMD 179/paper/Dresdae with *Myxotrichum deflexum*; **AMD, FH, G** George Winter, Fungi Europaei 1169/moist paper/Lipsiae?; **ANSM, G, HBG, MICH, NY** P.L. Ricker, Fungi Columbiani 1360/damp paper/Maine; **BR** Bommer and Rousseau/old newspaper/France?; Bommer and Rousseau/paper/France?; Magnagutim/music paper/France; Mme Rousseau/paper culture/France; Mme Rousseau/fiber culture/France; **BR, DBN, G, HBG, LE, TRTC** Zahlbruckner, Flora Austro-Hungarica 3180/paper/Austria; **BR, G** 179/paper/location undetermined (with *Myxotrichum deflexum*); **BR, G, LE, NY** Vindobonensi 2526/paper/Czechoslovakia; **BR, LE** Desmazieres/paper/France; **BR, LE, PAV** Rabenhorst 1169/paper/Lipsiae; **DAOM** 136693/rabbit dung/Ontario; 136710/rabbit dung/Ontario; 40998a/rotten paper/Czechoslovakia?; 49095 ex herb Inst. bot Strasbourg on sac-like material; 50966 ex Uppsala/cloth/Sweden?; **DBN** 207/grass/Ireland (King's Cliffe); **E** Saccardo 207/paper/straw/England; ?/cardboard/New York; Flora Exsiccata/paper/Austro-Hungarica; CMI 89072a&b/cardboard/England; **FH(P)** 431/S4793/leaves and fruit of *Carex* sp. sp;/location undetermined; **G** "vieux papier humide"/paper/France; Delessert 760/paper/France; Herb.

Barbey Boisier?/paper/Leipzig; 106/paper/France; **HBG** ex Herb. Eichelbaum/paper/Germany with dematiaceous conidial fungi; ex Herb. Richter/paper/Germany; **HBG, LE** Rabenhorst 1169/paper/Germany; **HBG, MICH, PAV, NY, TRTC** Cavara, Fungi Longobardiae 47/paper/Ticinensis; **HBG, NY, PAV** Saccardo 276/rotten paper/Italy; **LE** TIPO Auerswald/paper/Germany; **NY** ex Herb. George Massee/grouse dung/Balmoral Forest; Desmaziere 760/wet paper/France; **NY, RSA** 55/rotten board/Germany Neotype; **PAV** Herb. Ticinensis 415/paper/Italy; 106/paper/France; **RSA** 1191/cardboard/England; **TRTC** Paris 1134/rabbit dung/France?; **UAMH** 1997/soil/Japan; **UAMH, NY** 1598 (=CMI 89072a)/cardboard/England; **UPS** E; Fries/rotten cloth/France; **WIS** Ricker 534/paper/Maine; (as *Gymnoascus chartarum*): **FH, TRTC** Thaxter 5347/tarred paper/Maine; as *Gymnoascus* sp.: **O** ?/paper/Norway?.

Myxotrichum deflexum Berkeley, 1838 Ann. Nat. Hist. 1:260.
Figs 34e 36a,b
Type material: NEOTYPE (*cultura desiccata*) **NY** O-249 (soil, California). (Designated Orr *et al.*, 1963c).
≡*Eidamella deflexa* (Berkeley) Benjamin, Aliso 3:313, 1956.
=*Eidamella spinosa* Matruchot and Dassonville, Bull. Soc. Mycol. Fr. 17:123, 1901.
=*Eidamella papyricola* Saccas, Bull. Soc. Mycol. Fr. 66:121, 1950.

Ascomata: dark brown to almost black, globose, 200-450*u*m diam. excl. appendages. **Ascospores:** hyaline to pale yellow, ovoid, long-striate, 2.4-2.9 x 3.6-5.5*u*m. **Asci:** hyaline, obovoid to slightly clavate, 4.2-8.8 x 8.8-12.6*u*m. **Peridial hyphae:** dark brown, septate, branched, thick-walled, smooth, 2.6-5.8*u*m diam. **Appendages:** dark brown, monopodially branched, up to 200*u*m long, lateral branches sinuate, apices rounded, ±deflexed, to 60*u*m long; apices hyaline, 3.4-8.8*u*m at base. **Anamorph:** alternate arthroconidia infrequent. **In culture:** [UAMH 1651]. CER 21/25°C cream, felty, concentrically zonate; reverse yellow to ochre. DSA 28/25°C deep rose red, with clusters of black ascomata; reverse rose pink to hyaline at margin. PYE 21/25°C yellow, rugose wrinkled, felty, growth appressed; reverse deep rose. (Produces large amounts of diffusible red pigment).

Material examined: BR, G, HBG, LE, NY, PAV, PREM, RBH, TRTC, WIS Rabenhorst Fungi Europaei 2464/paper/England; **DAOM, TRTC** 146071/air of dwelling/Ontario; **E** ?/plaster board/Scotland; **FH** Orr 1075/?/?; Orr 232/?/?; Orr 238/?/?; **NY** Massee/from type/?Drawing; Orr 245/soil/California; Orr 3137/sand/Utah; Orr 3227/sand/Utah; 78-236A/*Solidago* sp. gall/Connecticut; **NY, RSA** 57/rotting board/Massachusetts; **NY, TRTC** Roumeguere 7366/rotten straw/France (with *Myxotrichum ochraceum*; **RSA** 203/rotten rug/California; **UAMH** 1582 (=Orr 11)/soil/California; 3200 (=CMI 109888)/soil/Ontario; **UAMH, NY** 1651 (=Orr 249)/soil/California, neotype strain as cited; as *Gymnoascus setosus*: **LE** Fungi Sibirica/?/USSR; Rabenhorst 179/paper/Italy (with dematiaceous hyphomycetes); **TRTC** Thaxter 5311/feathers/Argentina; Coll. Piquet/paper/Massachusetts; 41434/cow dung/India; as *Eidamella spinosa*: **TRTC** 31722/fingernails/Ontario.

Myxotrichum ochraceum Berkeley and Broome, 1875 Ann. Nat. Hist. IV 15:37.

Fig. 34d

Type material: Uncertain. Orr *et al.* (1963c) designated "Mycotheca Italica, 192" as neotype, stating Berkeley and Broome's original material was "unavailable for study." Massee and Salmon (1902) examined two specimens labelled "*Myxotrichum ochraceum*" by Berkeley and Broome. Using the original scanty description Orr *et al.*, *op. cit.* matched a selection from Saccardo's exsiccati. Orr *et al.* did not designate which duplicate was actually the neotype. Although choosing one of the duplicates of the "Mycotheca Italica" collection would be acceptable, an exhaustive search for the original material must first take place.

=*Myxotrichum speleum* Saccardo, Michelia 2:554, 1882 *fide* Orr *et al.*, 1963c.

≡*Myxotrichella spelaea* (Saccardo) Saccardo, Sylloge Fungorum 10:593, 1892. *fide* Orr *et al.*, 1963c.

Ascomata: dark brown, to almost black, globose, 150-500um diam. (excluding appendages). **Ascospores:** pale yellow, (ochre in mass) 1.6-3 x 3.6-5um, fusiform, faintly striate. **Asci:** hyaline, ±globose, 4.8-8.4um diam. **Peridial hyphae:** dark brown, thick-walled, branched, ending in short and elongated appendages. **Appendages:** dark brown, in two length classes: "short" - 90-180um in length, fragile with blunt or rounded apices; and "long," 200-1650um, 3.3-4.4um at base, fragile, paling in color to tip, up to 15 septate, straight, slightly bent, or curved apically, apex blunt, rounded or truncate, primarily and secondarily branched at proximal end. **Anamorph:** absent, or hyaline, terminal, pyriform aleurioconidia or intercalary cylindrical arthroconidia. On wheat germ agar RSA 1190 has bright ochraceous yellow mycelium with very black ascomata. No UAMH cultures examined.

Material examined: BR, DBN, G, HBG, LE, NY, PREM Rabenhorst, 1863/rotten wood/England; **BR** ?/straw/?; **HBG, NY, PAV** Saccardo Mycotheca Italica, 192/grass basket/Italy; **NY** Massee/bark/England (drawing); **RSA, UAMH** 1190 (=UAMH, 1904)/rotten cardboard/England.

Myxotrichum setosum (Eidam) Orr and Plunkett, 1963 Can. J. Bot. **41**: 1470-1471.

Type material: NEOTYPE **CMI** 471 (beehive comb, England). (Proposed).

≡*Gymnoascus setosus* Eidam, Bot. Cent. **10**:107, 1882 (Basionym).

Anamorph name: *Oidiodendron* state of *Myxotrichum setosum*, *fide* Sigler and Carmichael, 1976.

Ascomata: dark brown to black, globose. **Ascospores:** hyaline to pale green, fusoid with one flattened pole, 3-4 x 5-7.5um. **Asci:** ovoid, subglobose, 7-8um max. diam. **Peridial hyphae:** brown-black, thick-walled, septate, branches numerous, terminating in acute, spine-like apices. **Appendages:** dark brown, septate, thick-walled, with 2 or 3, opposite, short, whorled, sinuous branchlets at acute angles, often with short, pointed, lateral tooth-like projections. **Anamorph:** arthroconidia olive, thick-walled, smooth, cylindrical, developing in basipetal succession, slightly rounded, persistent, often septate, connections, 1.5-2 x 3-5*u*m. **In culture:** [UAMH 3835]. CER 21/25°C grayish green, thick felty, perimeter yellow; reverse yellow with pale green tinge. DSA 42/25°C khaki, dusty appearance; reverse concolorous. PYE 21/25°C grayish green, very thick, felty, concentrically folded; reverse red or yellow-brown.

Notes: Illustrations can be found in Massee and Salmon (1902) and in Dale (1903), and they are relatively similar. Orr *et al.* based their description on Eidam's original. Most collections under this name are either *Myxotrichum aeruginosum* or *Myxotrichum deflexum*. Orr *et al.* (1963) suggest that the autonomy of this taxon is maintained by elaborate branching of the ascoma and short branchlets arising in whorls on the main axes.

Material examined: CMI 471 (=UAMH 3939)/beehive comb/England; **NY** drawing by Massee; **UAMH** 3835 (=DAOM 144716)/soil/Alberta (1975).

Myxotrichum stipitatum (Lindfors) Orr and Kuehn, 1963 Can. J. Bot. **41**:1471-1472 FIG 17-22.

Figs 33b, 35b

Type material: NEOTYPE (*cultura desiccata*) **RSA** 1556 (sand dunes, England) *fide* Orr *et al.*, *op. cit.*

≡*Gymnoascus stipitatus* Lindfors, Svensk. Bot. Tidskr. **14**:270, 1920 (Basionym).

Ascomata: dark brown to brown-black, globose, 130-400*u*m diam. excl. appendages. **Ascospores:** hyaline to pale yellow, fusiform, 1.5-3.3 x 3.3-5.6*u*m. **Asci:** hyaline, stipitate, 6.4-8.8*u*m, stipes 4.8-12*u*m long. **Peridial hyphae:** dark brown, thick-walled, septate, to 3.5*u*m diam. branching frequently at 120 ° angles. **Appendages:** brown to brown-black, rigid, septate, straight or bent, 90-215*u*m long, and paling toward apex. On proximal end, lateral branches short, truncate or stubby - <20*u*m, deflexed, terminating in hyaline knobs or short branchlets. Apices fragile, hyaline and acuminate. **Anamorph:** absent or hyaline terminal and intercalary aleurioconidia. **In culture:** [UAMH 3165]. CER 42/25°C luxuriant, felty, grayish black, rose tinge at periphery; reverse brown in centre, perimeter fawn. DSA 42/25°C black, granular, ascomata on rosy pink, felty area; reverse pale orange-brown at centre. PYE 42/25°C tan with some reddish tinge; reverse yellow-orange.

Material examined: DAOM 144812, 175054, 175102/soil/Alberta. **FH, NY** O-518, O-521/soil/England. **NY** B40/?/?England. Warcup/?/England. O-655, O-2054/soil/Chile. **UAMH** 1510, 3165 (=CMI 61192, =RSA 1556)/sand dunes/England (neotype strain).

SPECIES EXCLUDED OR REFERRED TO OTHER GENERA

Myxotrichum aurantiacum (Peck) Saccardo, Sylloge Fungorum **4**:319, 1886

≡*Gymnascella aurantiaca* (Gymnoascaceae).

Myxotrichum brunneum Rostrup, Bot. Tidsskr., 19:206, 1895

=*Auxarthron umbrinum* (Onygenaceae).

Myxotrichum caesium Fries, Systema Mycologicum 3:348, 1832
≡*Gonytrichum caesium* Nees *fide* Hughes, 1958 (hyphomycete).

Myxotrichum conjugatum Kuehn, Mycologia 47:883, 1955
≡*Auxarthron conjugatum* (Onygenaceae).

Myxotrichum coprogenum Saccardo, Michelia 2:372, 1881
=*Gymnoascus reessii* (Gymnoascaceae).

Myxotrichum emmonsii Kuehn, Mycologia 47:539, 1955
=*Auxarthron umbrinum* (Onygenaceae).

Myxotrichum foliicola Niessl Nova Hedwigia 17:176, 1878 Nom. Nud. ex Saccardo, Saccardo, Sylloge Fungorum 4:319, 1886
≡*Cladotrichum foliicola* (Niessl) Ferro *fide* Ferro, Nuov. Giorn. Bot. Ital. II. 14 :228, 1907 (hyphomycete).

Myxotrichum herbariense (Orr and Kuehn) Apinis, Mycol. Pap. 96:22, 1964
≡*Tripedotrichum herbariense* Orr and Kuehn Mycologia 56:483, 1964 (*Species incertis est.*)

Myxotrichum ochraceum var. *stipitatum* (Lindfors) Apinis, 1964
=*Myxotrichum stipitatum.*

Myxotrichum poluninii Apinis, Mycol. Pap. 96:22 FIG 1, 2, 4a-h, PL III
=*Myxotrichum bicolor.*

Myxotrichum resinae Fries, Systema Mycologicum 3:349, 1832
=*Racodium aterrimum* Ehrenberg *fide* Saccardo, Sylloge Fungorum 4:320, 1886.
=*Alysidium resinae* (Fries) M. B. Ellis, 1971 (hyphomycete).

Myxotrichum spinosum Massee and Salmon, Ann. Bot. 16:64, 1902
=*Myxotrichum cancellatum.*

Myxotrichum thaxteri Kuehn, Mycologia 47:878, 1955
=*Auxarthron umbrinum* (Onygenaceae).

Myxotrichum uncinatum (Eidam) Schroeter, KryptogamenFlora von Schlesiens 3:212, 1893
≡*Uncinocarpus uncinatus* (Onygenaceae).

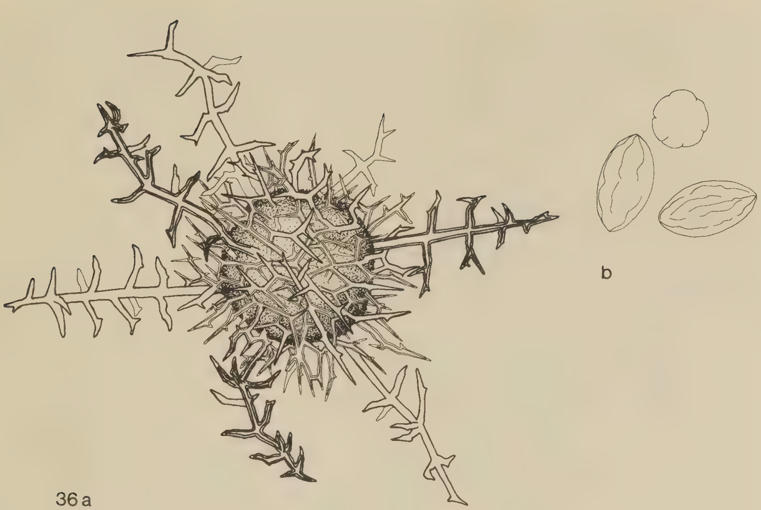
PSEUDOGYMNOASCUS Raillo, 1929

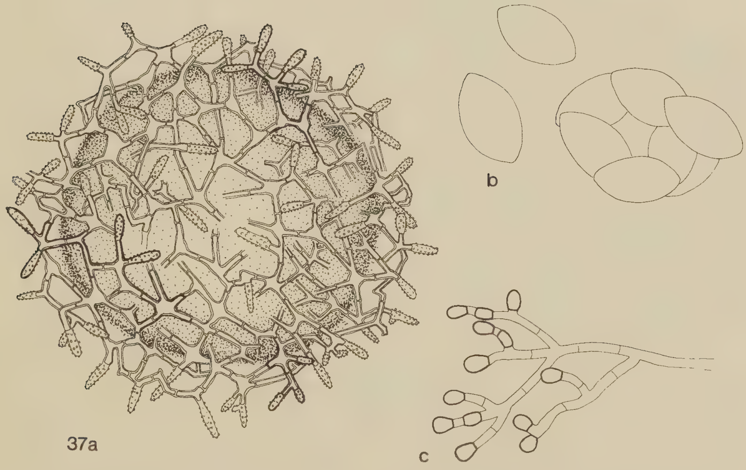
Zentralbl. Bakteriol. Paraditkde (Abth.2) 78:520.

Type species: *Pseudogymnoascus roseus* Raillo.

Ascomata: yellow or rose, globose, discrete or confluent. **Ascospores:** hyaline, pale yellow or pink, fusiform, smooth. **Asci:** globose to ovoid. **Peridial hyphae:** slightly thick-walled, smooth or asperulate, swollen at the nodes (points of branching and anastomoses), some free ends terminating in roughened, clavate cells. **Appendages:** not distinct, thin-walled, echinulate, or covered with warts, branches lacking. **Ascocarp initials:** ascomatal initials consisting of coiled ascogonia without a recognizable antheridium. **Anamorph:** aleurioconidia and arthroconidia in *Geomyces.*

Notes: Apinis (1964) considered this genus as a subgenus of *Gymnoascus*. The two are distinct enough to warrant not only their placement in different genera (based on ascospore morphology), but in different families. Close relationship





Figs 36-37. 36. *Myxotrichum deflexum* (LE Rabenhorst 2464). a. Ascoma with long, tapering appendages with deflexed branches. X175. b. Fusiform, striate ascospores. X2820. 37. *Pseudogymnoascus roseus* (RSA 1966). a. Ascoma with slightly thick-walled, branched and anastomosed, thick-walled peridial hyphae; nodal areas swollen; appendages echinulate. X390. b. Smooth, fusiform ascospores. X3625. c. *Geomyces* state showing dendritic conidiophore. X330.

was implied by the similarities in structure and color of the reticuloperidium. Von Arx (1981a) states that "the genera *Byssoascus*, *Pseudogymnoascus*, and *Myxotrichum* are related to *Neurospora* and *Faurelina*," but does not provide a discussion of this suggested relationship.

Pseudogymnoascus roseus Raillo, 1929 Zentrabl. Bakteriol. Parasitkde 78:515 FIG 2.
Figs 35a 37a,b,c
Type material: unknown.
≡*Gymnoascus roseus* (Raillo) Apinis, Mycol. Pap. **96**:8, 1964.
=*Gymnoascus rhousiogongylinus* Wener and Cain, Can. J. Bot. **48**:325, 1970.
=*Pseudogymnoascus vinaceus* Raillo, *loc. cit.*
≡*Gymnoascus vinaceus* (Raillo) Apinis, Mycol. Pap. **96**:9, 1964.
=*Pseudogymnoascus bhattii* Samson, Acta Bot. Neerl. **21**:519, 1972.
Anamorph name: *Geomyces* state of *Pseudogymnoascus roseus*, *fide* Sigler and Carmichael, 1976.

Ascomata: white at first becoming pinkish brown or rose to reddish brown, globose, 100-300um diam., single or in clusters. **Ascospores:** off-white at first, becoming pink or brown, yellow or yellow-brown, smooth-walled ±fusiform, 1.7-2.1 x 2.9-3.7um. **Asci:** globose, subglobose, 6.5-9 x 4-7um. **Peridial hyphae:** slightly thick-walled, rough or finely granular, branched, anastomosed, nodes swollen. **Appendages:** short, thin-walled, unbranched, echinulate or warty. **Anamorph:** aleurioconidia and arthroconidia minutely roughened, hyaline or very pale pink to brown; on dendritic conidiophores. **In culture:** [UAMH 1644]. CER 21/25°C rose-colored, flocculent mounded hyphae, orange rim; reverse deep reddish orange to brown. DSA 36/25°C white or very faint rose, felt-like; reverse yellow.

Notes: Raillo (1929) originally distinguished this genus from *Gymnoascus* on the basis of the structure of the peridium. Apinis (1964) placed the *Pseudogymnoascus* in synonymy with *Gymnoascus*. Samson (1972) pointed out that a more substantial reason for maintaining *Pseudogymnoascus* as a distinct genus was the fusoid shape of the ascospores. Also, unlike *Gymnoascus*, *Pseudogymnoascus* has an anamorph. Tsuneda (1982) presents a SEM study of this species.

Material examined: DAOM 66374/spruce roots /Saskatchewan; 170480, 170481, 170482/soil/Alberta; **NY** O-1116, O-1146, O-3389/alpine soil/Alberta; O-3595/forest soil/Alberta; O-3729/porcupine dung/Alberta; **RSA**, 1966/mouse dung/California; **TRTC** 45536/soil/Ontario; 45538/porcupine dung/Ontario; **UAMH** 1644/larch wood/Italy from Kuehn (1963) (obtained by Kuehn from Dal Vesco); 4055/oil soaked soil/Northwest Territories; as *Pseudogymnoascus bhattii*: **NY** O-1119/alpine soil/Alberta (holotype strain).

Onygenaceae Fries, 1849 Summ. Veg. Scand. 2:446.

Type genus: *Onygena* Persoon, Obs. Myc. 2:71

Ascomata: white to light-colored, or in shades of reddish brown; globose when discrete and <1000um diam., but often confluent and sometimes stromatic forming compound structures up to several cm in diam. **Ascospores:** hyaline to pale yellow or reddish brown, spherical or oblate, allantoid in several genera, walls always punctate to punctate-reticulate, ridges of puncta broad and smooth, or narrow and ragged giving a spiny appearance; often appearing almost smooth with the light microscope; usually <6um diam. **Asci:** ±globose or broadly clavate. **Peridial hyphae:** lacking or ±present in which case they may be: 1. undifferentiated from vegetative hyphae (telaperidium); or 2. thick-walled, tubular cells (reticuloperidium); or 3. thick-walled irregular cells which disarticulate (incompositoperidium); or 4. flattened and membranous forming a cleistoperidium; **Appendages:** lacking or well-developed, frequently crozier-like; thin-walled helices occasionally formed. **Sexuality:** heterothallic or homothallic. **Anamorph:** conidia with rhexolytic dehiscence; in genera *Chrysosporium*, *Malbranchea* or *Sporendonema*. **Degrades:** keratin (or nitrogenous compounds of animal origin).

Notes: The Onygenaceae consists of a relatively homogeneous group of genera with three prominent characteristics: rhexolytically dehiscing conidia, punctate ascospores, and the ability to break down keratin. The family is close to the smooth-spored Arthrodermataceae which also has rhexolytically dehiscing conidia and keratinolytic capabilities. Single-celled arthroconidia predominate in the Onygenaceae while nonseptate to multiseptate aleurioconidia predominate in the Arthrodermataceae. Two sizes of conidia are formed in both families. In the Onygenaceae, *Renispora* and *Ajellomyces* both produce large, globose, spiny conidia. Many of the Arthrodermataceae also form large ornamented conidia which may be either multiseptate (e.g. *Microsporum canis*) or nonseptate (e.g. *Chrysosporium* state of *Ctenomyces serratus*).

The potent pathogen, *Coccidioides immitis*, has an anamorph of alternate arthroconidia, and also causes a deep mycosis like *Ajellomyces*, rather than superficial ones found in the pathogenic members of the Arthrodermataceae. It has never been known to form a sexual state either *in vitro* or *in vivo*. Spherules which propagate the fungus in tissue by the formation of endospores have been sectioned at many different stages of development. Synaptonemal complexes have not been found, indicating that the spherule stage is not the site of meiotic events (personal communication, Cole, 1983). It is probable that this fungus will eventually be found to be a member of the Onygenaceae. The sexual stages of many parasitic fungi are often rare (e.g. *Ajellomyces*, *Filobasidiella*), and when formed have reduced structures accessory to meisopore production.

A different type of reduction has occurred in *Oncocladium flavum*. This keratinolytic fungus produces alternate

TABLE 14 GENERA OF ONYGENACEAE☆

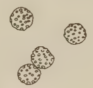
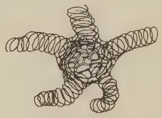
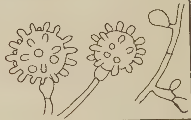
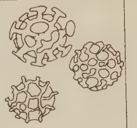
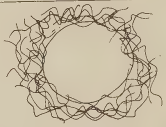
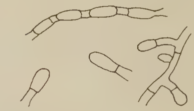
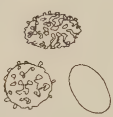
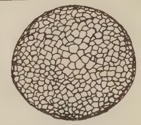
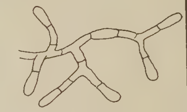
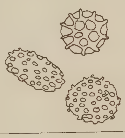
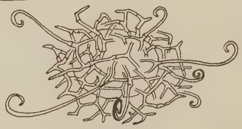
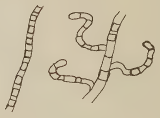
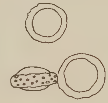
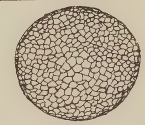
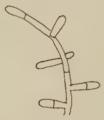
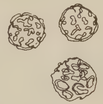
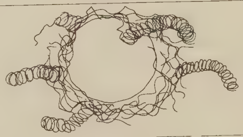
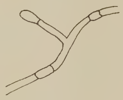
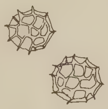
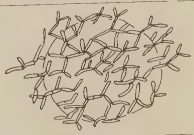
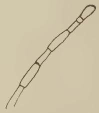
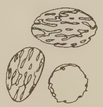
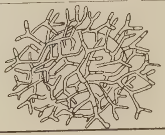
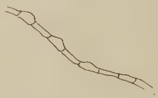
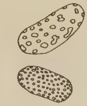
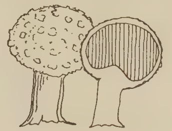
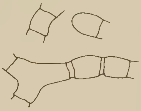
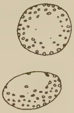
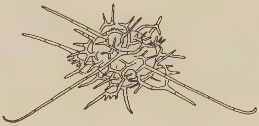
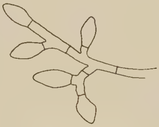
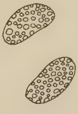
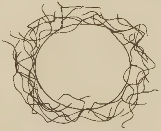
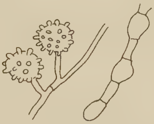
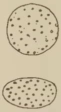
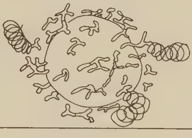
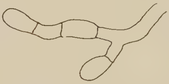
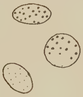
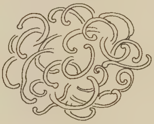
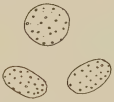
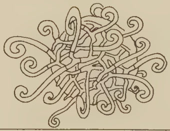
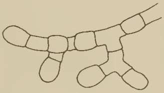
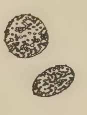
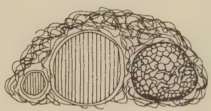
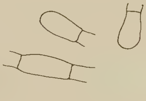
Genus	Ascospores	Peridia and Appendages	Anamorphs
Ajellomyces			
Amauroascus			
Aphanoascus			
Auxarthron			
Keratinophyton			
Kuehniella			
Nannizziopsis			
Neogymnomyces			

TABLE 14 (continued) GENERA OF ONYGENACEAE☆

Genus	Ascospores	Peridia and Appendages	Anamorphs
Onygena			
Pectinotrichum			
Renispora			
Shanorella			
Spiromastix			?
Uncinocarpus			
Xynophila			

☆*Apinisia, Ascocalvatia* and *Neoxenophila* are not figured.

arthroconidia in a mass of hyphae and thick-walled appendages that superficially resembles an ascoma. In fact, it was originally described as *Gymnoascus verticillatus* but there are no confirmed reports of ascospores being formed. An isolate which developed on coyote dung from southern Alberta produced characteristic appendaged ascoma-like masses on sheep's wool but not on artificial media. This suggests that this fungus (and probably other Onygenales) has specific nutritional requirements which affect morphogenetic processes. A similar event occurred with *Onygena* species grown on artificial media and on sterilized horse hoof. Growth on hoof demonstrated large, stipitate, sterile structures while isolates on agar grew more or less appressed to the medium and did not form characteristic or distinctive structures.

In general, the habitat of the Onygenales is dung and soil enriched with keratin. Occasionally the less specialized taxa (e.g. *Aphanoascus*) may be found on herbivore dung, where the keratin source is probably hair ingested during grooming.

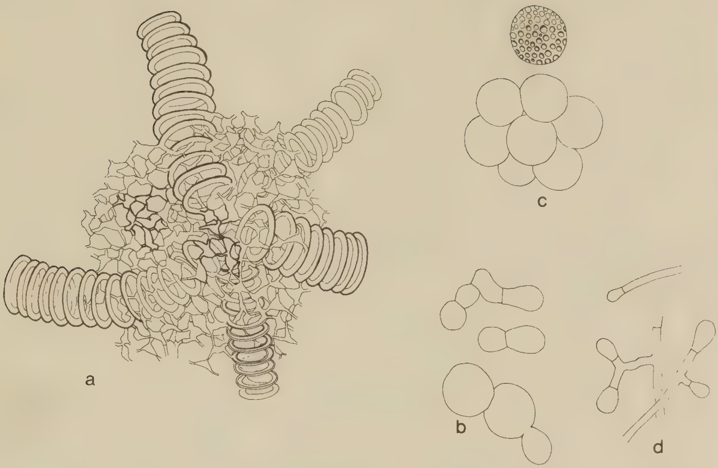
AJELLOMYCES McDonough and Lewis, 1968, em. McGinnis and Katz, 1979
(Mycologia **60**:76) Mycotaxon 8:157.

Type species: *Ajellomyces dermatitidis* McDonough and Lewis.
=*Emmonsiella* Kwon-Chung, 1972.

Ascomata: tan, globose to stellate, to 350µm diam. **Ascospores:** hyaline, globose, minute, <2µm diam.; TEM has shown puncta on the ascospore wall. **Asci:** subglobose, clavate to pyriform. **Peridial hyphae:** thin-walled, branching, constricted at septa and arising from the sides of coiled appendages. **Appendages:** thick-walled, septate helices arising from a common centre; inner walls thicker than outer walls. **Sexuality:** heterothallic; gametangia of swollen cells of unequal size. **Anamorph:** aleurioconidia in hyphal phase; yeast-like state at 37°C. **Degrades:** not strongly keratinolytic, prefers complex nitrogenous materials.

Notes: Kwon-Chung (1973) distinguished the genus *Emmonsiella* from *Ajellomyces* on the basis of morphology of ascoma initials, shape and size of asci and peridial hyphae. McGinnis and Katz (1979), in a detailed re-examination of both taxa, determined that differences maintained by Kwon-Chung, either could not be entirely substantiated or were not sufficiently distinctive to merit a new genus. They placed *Emmonsiella* in synonymy with *Ajellomyces*. Differences between the two are sufficient at the species level. Both species of *Ajellomyces* are serious pathogens of humans. Although teleomorphs have never been found in nature, they may be observed by plating appropriate strains together on artificial media.

References: Emmons, Binford, Utz and Kwon-Chung, 1977. (Clinical and epidemiological discussion of diseases caused by the two species in the genus). Glick and Kwon-Chung, 1973 (TEM of ascospores of *Ajellomyces dermatitidis* and *Ajellomyces capsulatus*). Kwon-Chung, 1973. (Illustrated



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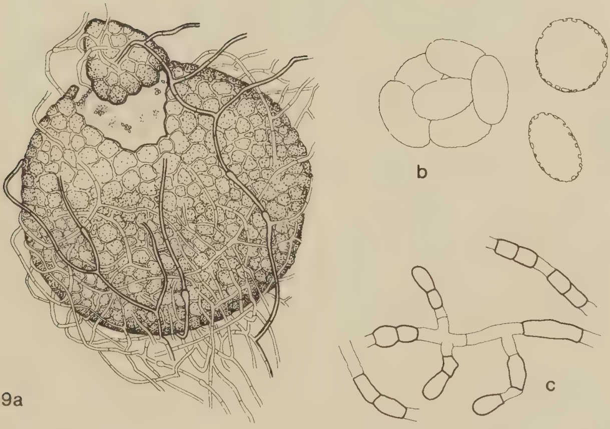


39a

Figs 38-39. 38. *Ajellomyces dermatitidis* (drawn from published descriptions). a. Ascoma with broad helices originating from centre of ascoma and giving rise to peridial hyphae which are swollen between septa. X155. b. *Zymonema* state; globose, vegetative cells of yeast phase. (Redrawn from Emmons *et al.* X590. c. Minute, spherical, punctate ascospores. X4860. d. *Chryosporium dermatitidis*. Solitary, pyriform aleurioconidia. X625. 39. *Aphanoascus canadensis* (UAMH 4574). a. Ascoma with cleistoperidial wall. X100. b. Ascus and individual, oblate ascospores (individual spores show punctum pattern). X2700. c. Anamorph of arthro and aleurioconidia. X400.

developmental study). Kwon-Chung, 1975. (Taxonomic status of species causing large-form African histoplasmosis).

Ajellomyces capsulatus (Kwon-Chung) McGinnis and Katz, 1979 Mycotaxon 8:157.

Type material: HOLOTYPE (*cultura desiccata*) **BPI** 71811.

≡*Emmonsiella capsulata* Kwon-Chung, Science 177:368, 1972

Anamorph names: *Histoplasma capsulatum* Darling (1906), was applied to the yeast phase. Carmichael (1962) included the conidial phase in *Chrysosporium*. (Detailed lists of synonyms of the anamorph name used here may be found in De Vries, 1983).

Ascomata: yellowish tan, globose to subglobose, 80-250*u*m. **Ascospores:** hyaline, globose, smooth, (TEM shows regular puncta of walls), 1.2-1.5*u*m diam. **Asci:** subglobose, clavate to pyriform, to 7*u*m maximum. **Peridial hyphae:** swollen, thin-walled, sinuous hyphae developing from helical appendages, anastomosing and branching dichotomously, not swelling between septa (walls remain parallel). **Appendages:** cream to pale tan, thick-walled helices, 1.7-3*u*m diam., originating from centre of ascoma, 30-100*u*m long; (2)3-5(10) per ascoma. **Anamorph:** Microconidia globose or pyriform, smooth, spiny or finely roughened, 2-6*u*m diam., sessile or on short, narrow (rarely inflated) conidiophores which develop at right angles from parent hyphae. Macroconidia spherical, (rarely pyriform), ornamented with broad tubercles; 8-14*u*m diam., borne in the same manner as the microconidia. **In culture:** at 30°C and lower: white, downy at first, becoming buff to brown; resembling *Ajellomyces dermatitidis*, but having a slower growth rate. Grows as a yeast at 37°C.

Notes: Causative agent of systemic mycosis (Histoplasmosis, Darling's disease, reticuloendothelial cytomycosis, reticuloendotheliosis) (Emmons *et al.*, 1977). In tissue (and in culture at 37°C) this fungus forms a yeast-like state of oval cells, 2-3 x 3-4*u*m, which bud at narrow ends through very narrow (0.2-0.3*u*m diam.) pores. Found throughout the tropical and temperate parts of the new world in areas with red-yellow, podzolic soils, especially if enriched with bat or bird dung.

Ajellomyces dermatitidis McDonough and Lewis, 1968 Mycologia 60:77 FIG 1-6.

Figs 38a,b,c,d

Type material: HOLOTYPE (*cultura desiccata*) **CDC** (human isolates, North America?).

Anamorph name: *Chrysosporium dermatitidis* (Gilchrist and Stokes) Carmichael *fide* Carmichael, 1962 (Synonyms may be found in Carmichael *op. cit.*) (Yeast state in form-genus *Zymonema*).

Ascomata: tan, globose to subglobose, 200-350*u*m diam. **Ascospores:** hyaline, globose, appearing smooth by LM but TEM shows regular puncta, 1.3-1.6*u*m. **Asci:** subglobose, clavate to pyriform, 3.8-7.5*u*m diam. **Peridial hyphae:** pale brown or reddish brown, arising from coils, anastomosing and branching dichotomously, swelling between septa which are 0.25-1.5*u*m diam.; cells 1.5-4.5 x 1.5-10.5*u*m diam.

Appendages: generally 3-5, thick-walled, helical hyphae, 2.3-7.5*u*m diam., inner walls thickened. **Anamorph:** aleurioconidia solitary, globose or pyriform, smooth, sessile or pedicellate, lateral or terminal, 2-10*u*m diam. **In culture:** mycelial at 30°C and lower: forming moist, ±synnematal aggregations with a variable amount of white or brownish aerial mycelium, and with or without a diffusible brown pigment.

Notes: At 37°C and in animal tissues, this fungus grows as globose, thick-walled yeast cells, 8-15*u*m diam., with unipolar (occasionally bipolar) blastoconidia which are broadly attached to parent cell (4-5*u*m at point of attachment). The mycosis caused by *Ajellomyces dermatitidis* is recorded from North and South America and Africa but the natural habitat of the fungus is unknown. It has been isolated from soil (rarely) (Emmons *et al.*, 1977).

AMAUROASCUS Schroeter, 1893

KryptogamenFlora von Schlesiens 3:211.

Type species: *Amauroascus niger* Schroeter. (Lectotype *fide* Clements and Shear, 1931).

Ascomata: white, yellow, or brown, ±globose or ellipsoid, to 2.5mm in diameter. **Ascospores:** hyaline, yellow, or reddish brown to dark brown, spherical, with a definite pattern of pronounced, irregular or regular puncta and ridges, 3.5-8.7*u*m diam. **Asci:** ovoid, to 14*u*m maximum, 8-spored. **Peridial hyphae:** usually undifferentiated in culture, but occasionally pale brown, ±smooth and thick-walled. **Appendages:** lacking. **Anamorph:** terminal and/or intercalary, rhexolytically dehiscing conidia. **Degrades:** keratin.

Notes: The genus *Amauroascus* was erected by Schroeter to include species with small, spiny, brown or violet ascospores within a peridium of loosely interwoven, undifferentiated hyphae. Its relationship to *Arachniotus* (*sensu* Schroeter) was considered close (Benjamin, 1956; Kuehn, 1958), or congeneric (Orr and Varsavsky, 1965), until Von Arx (1971) distinguished the taxon on the basis of the spherical, ornamented ascospores. Von Arx, without explanation, designated the lectotype of the genus as *Amauroascus verrucosus* (=*Amauroascus mutatus* (Quelet) Rameloo q.v.). Clements and Shear (1931) and Benjamin (1956) had previously cited the lectotype as *Amauroascus niger* and according to article 8.1 (ICBN) this choice must be followed. Schroeter did not indicate which of the two taxa he had selected for type.

Von Arx transferred *Arachniotus aureus* and *Arachniotus albicans* (Apinis, 1964) to *Amauroascus* on the basis of spore shape and ornamentation. This move is substantiated by the keratinolytic abilities of the two taxa. *Pseudoarachniotus echinulatus* Dutta and Ghosh (1963) was also transferred to *Amauroascus* by Von Arx, but I disagree with this disposition. This species is not keratinolytic. The ascospores possess prominent, blunt, cone-shaped spines rather than the puncta typical of *Amauroascus*. It does not have an anamorph. Consequently there is no reason to keep

Pseudoarachniotus echinulatus in the Onygenales.

Von Arx maintained that, on the basis of gametangial morphology, *Amauroascus* had a close relationship to *Narasimhella* (see *Gymnascella hyalinospora*), but I consider them very different and distantly related taxa.

Amauroascus is most closely related to *Auxarthron*. Both of these genera have markedly punctate ascospores. The distinction between the genera is not clear-cut, but the major features distinguishing *Amauroascus* from *Auxarthron* are the much larger puncta on the ascospore wall and the general absence of differentiated peridial hyphae in *Amauroascus*. *Amauroascus kuehnii* and *Amauroascus pseudoreticulatus* represent species which are intermediate between the two genera, in that they have differentiated peridial hyphae which are similar to those of *Auxarthron*. Some reservation must be employed in differentiating these two genera on the basis of peridial hyphae, since the species are known in most detail on artificial culture media and there may be some limitations on their morphological expression in this environment. Clarification of the limits of the two genera requires more extensive work in collection and isolation of new strains, particularly of *Amauroascus*, which is quite rare.

Because there are so few isolates of representatives of this genus, statements about habitat are mostly speculative. Since, in culture, all isolates of the genus are keratinolytic, *Amauroascus* is probably a saprophyte of keratinous debris and soil is the most probable habitat. The isolation of *Amauroascus aureus* from wood is puzzling, although the presence of small amounts of keratin in the vicinity of the collection might have been overlooked.

None of the species of *Amauroascus* has been implicated as an animal pathogen.

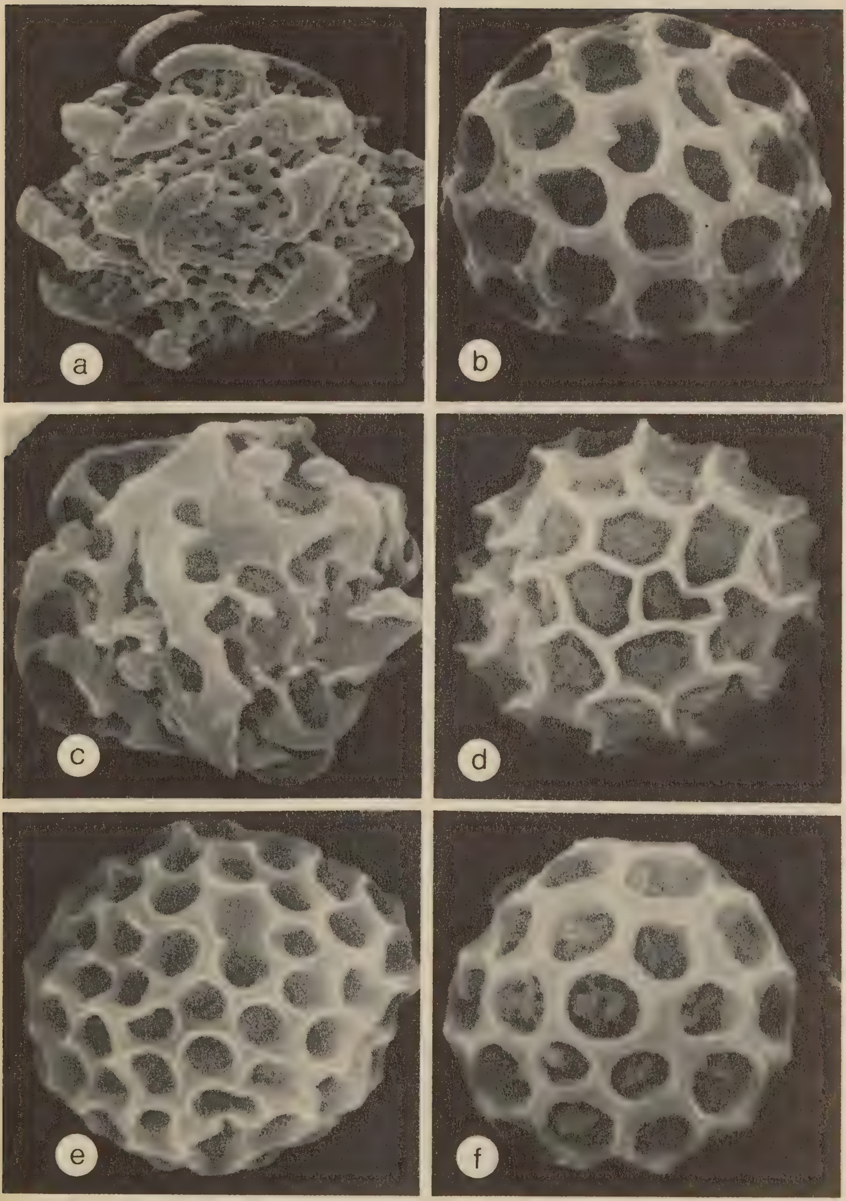
Amauroascus albicans (Apinis) von Arx, 1971 Persoonia **6**:376. Fig 40e

Type material: HOLOTYPE (*cultura desiccata*) **CMI** (=BDUN 264) (soil, England).

≡*Arachniotus albicans* Apinis, Mycol. Pap. 96:45, 1964 PL III FIG 10 a-m (Basionym).

Ascomata: white or cream, globose, 0.3-1(2)mm, single or

Fig. 40. a. *Amauroascus mutatus* (UAMH 3563). Spherical, punctate ascospore with hoodoo-like pila projecting beyond the finely punctate surface. X7200. b. *Amauroascus volatilis-patellis* (UAMH 3406). Spherical ascospore with broad, deep, regularly-shaped pits. Some smaller puncta on outer rim surface. X10260. c. *Amauroascus niger* (UAMH 3544). Spherical ascospore with irregular punctum pattern. X12240. d. *Amauroascus aureus* (UAMH 3157). Broad, polygonal puncta with regular rims. Pit floors ornamented with smaller pits. X11880. e. *Amauroascus albicans* (UAMH 3402). Spherical ascospores with numerous, deep, circular pits. X15120. f. *Amauroascus kuehnii* (UAMH 3). Spherical ascospore with deep, round, regular pits. X13680.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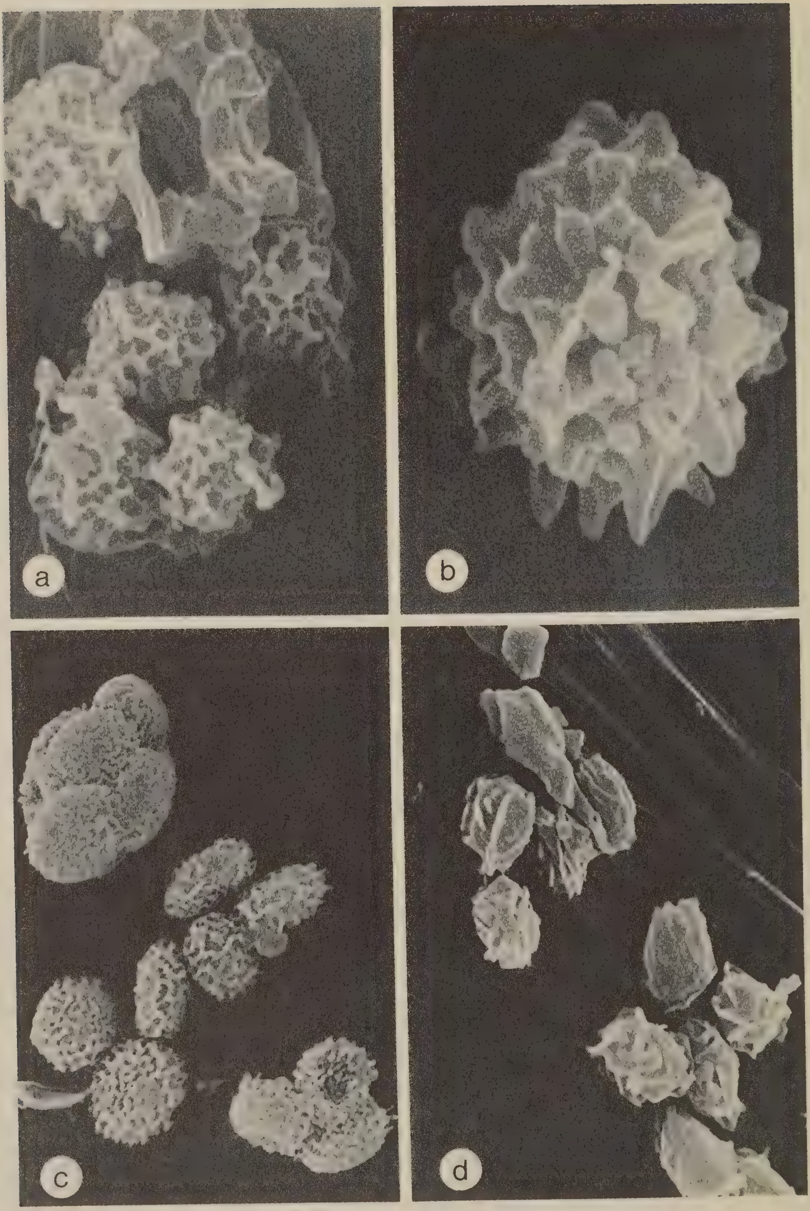
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in clusters. **Ascospores:** hyaline, globose to subglobose, punctate-reticulate, 3-4.5(-5)*u*m. **Asci:** ovoid, 8-11 x 11-17*u*m. **Peridial hyphae:** hyaline, undifferentiated, delicate, loosely interwoven. **Anamorph:** conidia hyaline, solitary, smooth, pyriform, one-celled, 3.5-4.5(-6.5) x 4.5-7.5*u*m. **In culture:** [UAMH 3102]. CER 42/25°C white, wispy to felty mat with pale yellow knots. DSA 49/25°C pale yellow, granular, scant. PYE 42/25°C dense felty white; reverse orange-brown.

Material examined: as *Arachniotus albicans*: **UAMH** type strain as cited; from Orr; **NY** O-3220/Soil/Germany (Utah?).

Amauroascus aureus (Eidam) von Arx, 1971 Persoonia **6**:375.
Fig. 40d
Type material: NEOTYPE (?) **RSA** 1532 (decayed wood of *Cryptomeria japonica*, Japan).
≡*Gymnoascus aureus* Eidam, Ber. Bot. Sect. Schles. Ges. **64**:161, 1887 (Basionym).
≡*Arachniotus aureus* (Eidam) Schroeter, KryptogamenFlora von Schlesiens **3**:210, 1893.

Ascomata: shades of yellow, usually discrete, ±spherical, 300-1000*u*m and/or naked clusters of asci, 70-350*u*m. **Ascospores:** hyaline to pale yellow, yellow in mass, 3.3-5.5*u*m diam., punctate-reticulate, conglobate. **Asci:** globose, subglobose or ellipsoidal, 9-13*u*m diam. **Peridial hyphae:** 1. yellow, smooth, thin-walled, septate, branched, rather straight, 2-4.4*u*m diam.; and 2. branching, sinuate hyphae, 2-2.2*u*m diam. **Anamorph:** conidia long, narrow, 2.2 x 10*u*m, often constricted at septa, clavate to elongate, hyaline, finely tuberculate, 3.3-7 x 5.5-20*u*m, pedicellate or sessile, base narrow or broad, lateral, terminal or intercalary. *Chrysosporium* anamorph *fide* Kuehn, Tubaki and Orr, 1964. **In culture:** [UAMH 3157]. CER 21/25°C bright lemon-yellow, fluffy or felty, with a broad margin of hyaline hyphae; reverse light yellow. DSA 42/25°C hyaline with numerous cottony, citrine yellow, pulvinate masses; reverse yellow. PYE 35/25°C brilliant yellow, thick-felty, granular; reverse brownish yellow.

Material examined: as *Arachniotus aureus*: **RSA** (neotype as cited) (=UAMH 3157); **NY** Brandsberg Mo-32/soil/Missouri (dried culture); as *Arachniotus* sp.; **UPS** Bjorkman/wood of the 'Vasa'/Sweden, (dried culture).

Amauroascus kuehnii Von Arx, 1971 Persoonia **6**:376.
Figs 40f 42c,d
Type material: TYPE STRAIN **UAMH** 3 (bat dung dust, Georgia).

Fig. 41. a. *Amauroascus niger* (UAMH 3544). Thick-walled ascospores with irregular pits. X4770. b. *Amauroascus echinulatus* (UAMH 3561). Ascospore ornamented with broad, blunt spines. X11520. c. *Aphanoascus fulvescens* (UAMH 4603). Ascospores with irregular pits and ascal cluster. X2880. d. *Aphanoascus cinnabarinus* -Udagawa and Takada (UAMH 3652). Ascospores with narrow, flange-like projections. X2340.

≡*Arachniotus reticulatus* Kuehn, Mycologia **49**:57, 1957 FIG 1-18, 31.

Non *Amauroascus reticulatus* (Kuehn and Goos) Von Arx, 1971 (see notes under *Amauroascus pseudoreticulatus*).

Ascomata: yellow to brown at maturity, 130-900*u*m diam. **Ascospores:** pale yellowish brown, punctate-reticulate, 3.5-4.2*u*m diam. **Asci:** hyaline, oblong, 7-8.4 x 11.2-12.6*u*m. **Peridial hyphae:** hyaline, thin-walled and scarcely differentiated, and some moderately thick-walled, brown, faintly tuberculate, branched and anastomosed. **Anamorph:** smooth, hyaline, intercalary conidia, 2-4 x 2.8-8.4*u*m. **In culture:**[UAMH 3]. CER 21/25°C white to pale ochre, cottony becoming granular in older portions; reverse uncolored. DSA 28/25°C ochre brown with knots of dark brown in the vicinity of hair; reverse uncolored. PYE 35/25°C yellow, dense, felty, purplish brown toward centre, margin white; reverse buff tan.

Notes: Von Arx changed the species epithet since "reticulatus" was already occupied in *Amauroascus* (but see notes under *Amauroascus pseudoreticulatus*). *Amauroascus kuehnii* is similar to *Amauroascus volatilis-patellis* but has shallower puncta on the ascospore walls.

Material examined: RSA 403/dung/California; 1253/dung/Arizona; 1254, 1505/mouse dung/California; 1439, 1478/lizard dung/Mexico; **UAMH** 3 (type strain as cited).

Amauroascus mutatus (Quelet) Rammeloo, 1982 Bull. Jard. Bot. Nat. Belg. **52**:241-243 FIG 1-6.

Fig. 40a

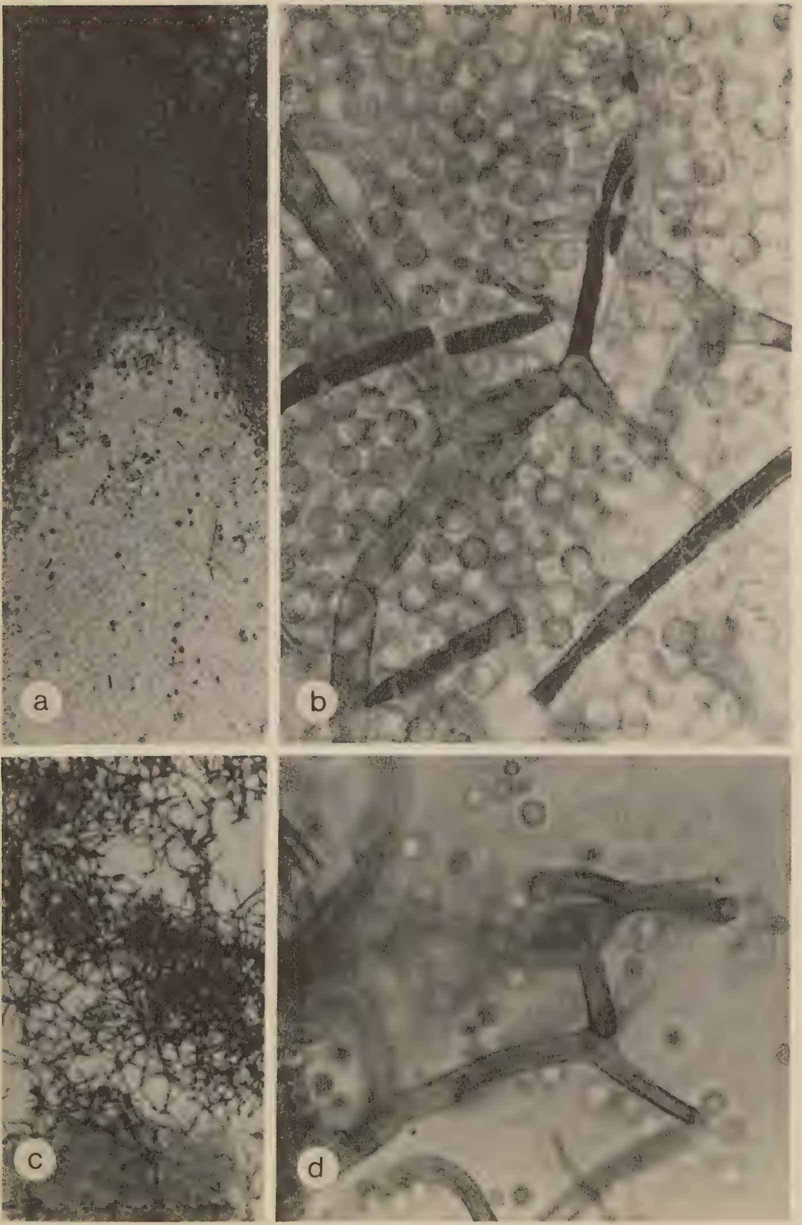
Type material: LECTOTYPE (natural material). **UPS** Bresadola (hair filled material, France). (*fide* Rammeloo 1982).

≡*Onygena mutata* Quelet, Mem. Soc. Emul. Montbeliard **5**:449, 1875. (Basionym).

=*Gymnoascus verrucosus* Eidam, Ber. Bot. Schles. Ges. **64**:162, 1886. (cited in Rammeloo, *op. cit.*).
≡*Amauroascus verrucosus* (Eidam) Schroeter, KryptogamenFlora von Schlesiens **3**:211, 1893.
≡*Arachniotus verrucosus* (Eidam) Kuehn, Orr and Varsavsky, Mycopathol. et Mycol. Appl. **25**:103, 1965.

Ascomata: white, becoming brown, spherical, 0.8-6mm, diam. **Ascospores:** brownish at maturity, punctate-reticulate with prominent capitate spines up to 1*u*m in length and resembling "hoodoos"; 6-8.7*u*m diam. including spines. **Asci:** 15-17 x 18-24*u*m, 8-spored. **Peridial hyphae:** in culture not distinctive, hyaline, thin-walled, smooth, 2-3.3*u*m diam.; in nature forming a crust-like covering on surface of ascomata.

Fig. 42. a. *Amauroascus pseudoreticulatus* (RSA 1426). Conglomeration of ascospores and thick-walled hyphae which lack recognizable peridial organization. X65. b. *Amauroascus pseudoreticulatus* (RSA 1426). Spherical ascospores with broad, polygonal puncta on surface. X880. c. *Amauroascus kuehnii* (RSA 1254). Thick-walled peridial hyphae. X65. d. *Amauroascus kuehnii* (RSA 1254). Thick-walled hyphae and punctate ascospores. X1130.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Anamorph: arthroconidia, 1.4-2.6 x 5.3-19*u*m. **In culture:** [UAMH 3576]. CER 42/25°C white, subcottony, thin. DSA 42/25°C white, dusty. PYE 42/25°C white with pale yellow areas (indicating "pockets" of ascospores); reverse orange to yellow orange.

Notes: Recorded from: rotten leather boot, Germany (Eidam, 1887); decaying feathers, France (Dangeard, 1907); soil, England (Apinis, 1964); Germany, Argentina (Orr *et al.*); soil/dung, Belgium, Argentina and Italy (Ajello *et al.*, 1965).

Material examined: UPS (type as cited); **NY** P 526/soil/Oklahoma (=UAMH 3576); O-3162/soil/California.

Amauroascus niger Schroeter, 1893 KryptogamenFlora von Schlesiens **3**:211.
Figs 40c 41a
Type material: NEOTYPE STRAIN **UAMH** 3544 (soil, California).
≡*Arachniotus niger* (Schroeter) Kuehn *et al.*, Mycopathol. et Mycol. Appl. **25** :106, 1965.

Ascomata: red-brown to grayish brown when mature, discrete, globose, 0.5-2.5mm. **Ascospores:** red-brown, black in mass, thick-walled, globose, irregularly punctate-reticulate, 4-6*u*m diam. **Asci:** ellipsoid, 10-12 x 11-14*u*m. **Peridial hyphae:** barely differentiated when young, becoming thicker and pale brown with age, 2-3*u*m diam. **Anamorph:** irregular arthroconidia in vicinity of ascospore production, 1.5-2.2 x 10-15*u*m. **In culture:** [UAMH 3544]. CER 35/25°C numerous dark brown tuberculate tufts over hyaline mycelium. DSA 42/25°C yellow to reddish tan, floccose around hair. PYE 42/25°C grayish yellow, dense-felty mat; reverse grayish.

Notes: Apinis (1964) did not deal with this taxon since it was known only from Germany and USSR. Orr described the spores as "globose with a fluted rim."

Material examined: UAMH 3544 (neotype strain as cited).

Amauroascus pseudoreticulatus Currah *sp. nov.*
Typus: HOLOTYPUS **UAMH** *3117 (cultura desiccata "OAT") (fimo lacerti, Mexicensis)*

Ascocarpi ochracei aut olivacei, discreti, globosi, 80-1600um. Ascosporae aureae, globosi, murae incrassatae, reticulato-venosae, 4.5-6um. Asci globosi, 8.5-9.um Hyphae peridii ochraceae, murae incrassatae, tuberculatae, constrictia ad septi, 3.5-6um. Stat. conid. absens. In

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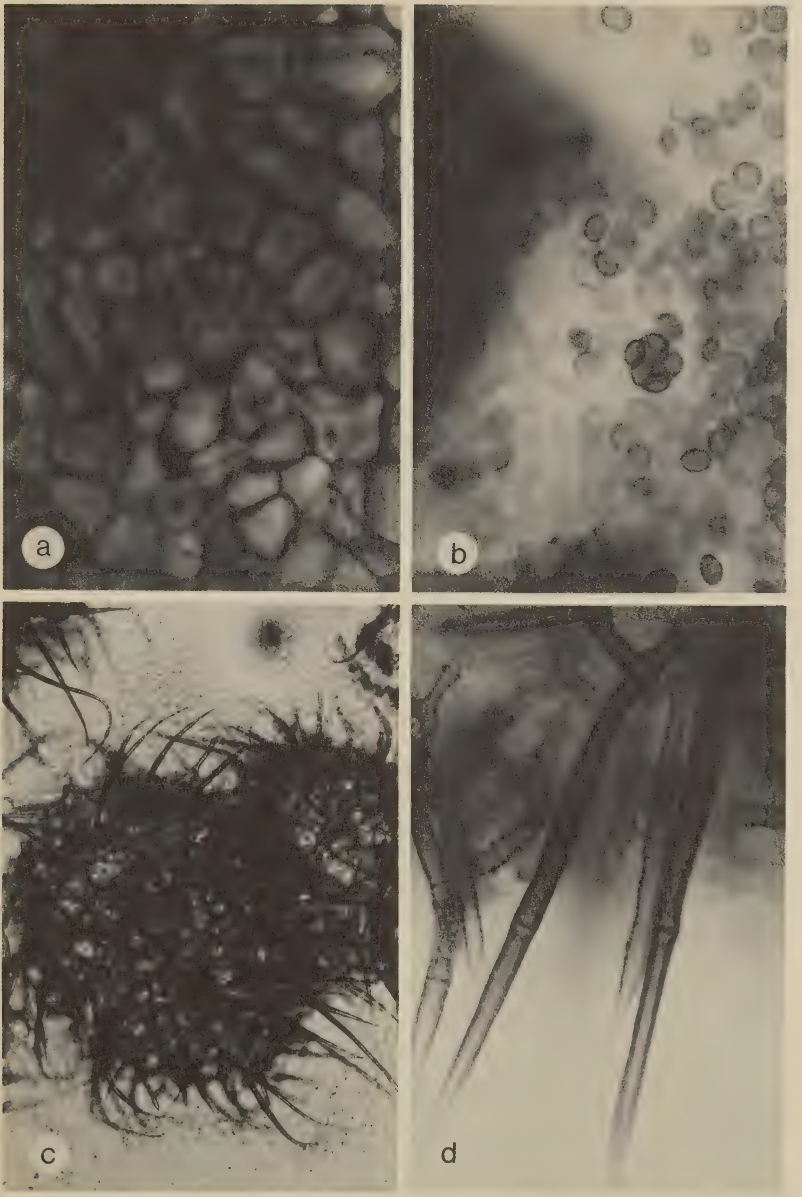
Fig. 43. a. *Aphanoascus canadensis* (UAMH 4574). Surface appearance of membranous peridium. X1200. b. *Aphanoascus canadensis* (UAMH 4574). Globose asci and individual, thick-walled, oblate ascospores from ruptured cleistoperidium. X990. c. *Auxarthron* sp. RC1 (UAMH uncatalogued). Reticuloperidium with long, curved, needle-like, septate appendages. X195. d. *Auxarthron species RC1* (UAMH uncatalogued). Septate, needle-like appendages paling in color toward apices. X1440.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cultura: CER 35/25°C mycelia aureo-rubiginosa caespitosa, reverso brunneo; OAT ascocarpi ochracei abundans.

Amauroascus pseudoreticulatus Currah sp. nov.
Figs 42a,b
Type material: HOLOTYPE **UAMH** 3117 (*cultura desiccata*) (on OAT) (lizard dung, Mexico).

Ascomata: ochre to olive, discrete, globose, 80-1600um. **Ascospores:** golden yellow, globose, thick-walled, regularly punctate-reticulate, 5-6um diam. **Asci:** ±globose, 8.5-9um. **Peridial hyphae:** ochre, tuberculate, thick-walled, constricted at septa. **Anamorph:** lacking. **In culture:** [UAMH 3117]. CER 35/25°C bright rusty yellow with many discrete tufts; reverse brown. DSA 42/25°C cinnamon brown with discrete globose tufts; reverse concolorous or slightly darker. PYE 42/25°C fawn yellow, slightly cottony to granular; reverse reddish brown.

Notes: This taxon is described to accommodate two isolates which have been misidentified as *Amauroascus reticulatus* (Kuehn and Goos) Von Arx (1971). The type of *A. reticulatus* was isolated from the rhizosphere of *Musa sapientium* and has sheathed ascospores which closely resemble those of *Amauroascus* in size. (see Fig 51d). Since *A. reticulatus* does not attack keratin, it is excluded from the family. The sheathed ascospores exclude it from the Onygenales.

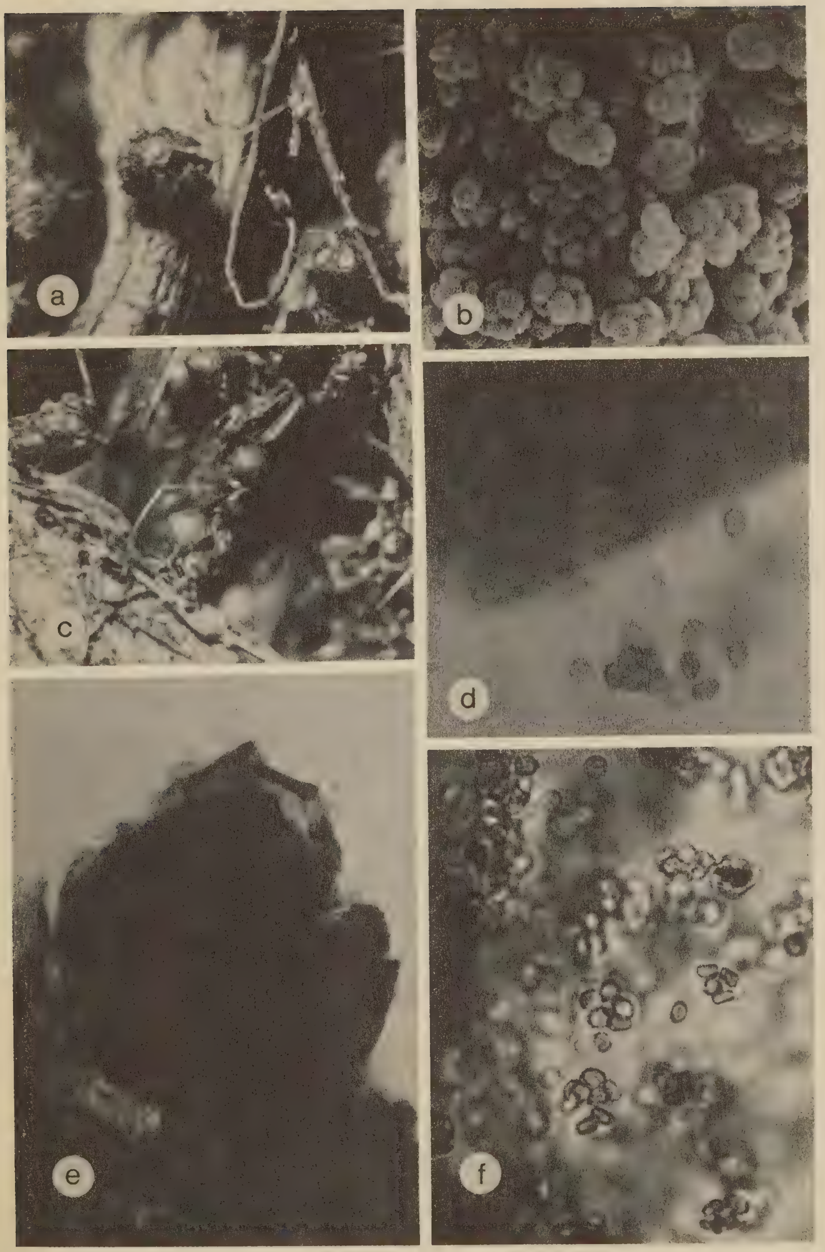
A. pseudoreticulatus is transitional between *Amauroascus* and *Auxarthron* in having punctate reticulate ascospores and differentiated peridial hyphae. In spite of the differentiation in the peridial hyphae, the taxon is best placedin *Amauroascus* due to the size of the ascospores and the large puncta in the ascospore wall.

Material examined: RSA 1426 (=UAMH 3117), 1502/lizard dung/Mexico.

Amauroascus volatilis-patellis (Orr and Kuehn) comb. nov..
Fig. 40b
Type material: HOLOTYPE **NY** DPG 140 (clay soil, Utah).
≡*Arachniotus volatilis-patellis* Orr and Kuehn, Mycologia **64**:61, 1972 FIG 7-8 (Basionym).

Ascomata: white, globose, 270-550um diam. **Ascospores:** hyaline, spherical, 5-6um diam., broadly punctate-reticulate. **Asci:** spherical, 12-16um diam. **Peridial hyphae:** hyaline, 1.9-3.8um wide, undifferentiated.

Fig. 44 a. *Aphanoascus fulvescens* (UAMH 4603). Habit view of ascoma on natural material (dung). X15. b. *Aphanoascus fulvescens* (UAMH 4603). Punctate, oblate ascospores in ascal clusters within an ascoma . X1045. c. *Aphanoascus fulvescens* (UAMH 4603). Habit view of several ascomata on natural material. X10. d. *Aphanoascus fulvescens* (UAMH 4603). Membranous, pigmented ascoma wall and oblate ascospores. X1110. e. *Aphanoascus fulvescens* (UPS Feurich). Squashed ascoma . X120. f. *Aphanoascus fulvescens* (TRTC 32680). Punctate-reticulate ascospores (appearing spiny) individual and in ascus clusters. X760.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Appendages: lacking. **Anamorph:** hyaline, subspherical to clavate, terminal conidia 2-3 x 4.3-5.2μm, and irregular, cylindrical, intercalary arthroconidia, 2-2.7 x 4-5.4μm. **In culture:** [UAMH 3406]. CER 35/25°C yellowish orange, glabrous in central region, hyphal mat mostly white, thin; reverse tan-yellow. DSA 42/25°C pure white, granular; reverse uncolored. PYE 49/25°C citrine yellow in centre; reverse deep reddish brown.

Notes: Ascospore morphology was misinterpreted in Orr and Kuehn's original description. The puncta are exceptionally deep and broad, giving the perimeter of the ascospores an opaque quality which differs substantially from the central region overlying the core. Orr and Kuehn described the perimeter as a "scalloped marginal band" resulting in a comparison of the ascospores to "flying saucers."

Material examined: NY (type as cited), (=UAMH 3406 from Orr).

APHANOASCUS Zukal, 1890

Ber. Deut. Bot. Ges. 8:296.

Type species: *Aphanoascus fulvescens* (Cooke) Apinis.
=*Anixiopsis* Hansen, 1897.

Ascomata: yellow-brown to dark brown, ±globose, 100-400μm diam. **Ascospores:** yellow-brown, ±oblate to ovoid, with numerous, minute, irregular puncta, 2.5-5.5 x 3.8-8.5μm. **Asci:** ±globose, thin-walled. **Appendages:** lacking. **Peridial hyphae:** reddish brown, several layers of flattened cells forming a membrane; outer layer thick-walled. **Sexuality:** Homothallic. Subglobose to slightly elongated and curved ascogonia; slender hyphae growing out from the basal cell develop closely attached to the ascogonial cell and branch to form the peridium (Domsch, Gams and Anderson (1980)). **Anamorph:** *Chrysosporium*. **Degrades:** keratin.

Notes: The nomenclature of this genus has been clarified by Apinis (1968). The same fungus had been described on three separate occasions in less than 30 years. The type species of *Aphanoascus* was first described by Cooke as a member of the myxomycete genus *Badhamia* (1875). Realizing that the fungus was an ascomycete, he then transferred the species to *Eurotium* in 1879. Hansen (1897) independently described the new ascomycete genus *Anixiopsis* on the basis of an isolate he labelled *Anixiopsis stercorarius* from fox dung. Zukal (1890) described *Aphanoascus cinnabarinus* from alligator dung. Apinis, after examining the type material of the three names took Cooke's species epithet and combined it with the genus name *Aphanoascus*, because of its obvious differences from *Eurotium*.

De Vries (1969) felt that ascospore size and ornamentation differed between *Anixiopsis* and *Aphanoascus* and recognized this at the variety level. After examining over 40 collections, I feel that distinction at this level is unwarranted. The complex pattern of puncta of the ascospore walls, and the often misinterpreted, oblate shape have given rise to confusion in this taxon. Apinis placed the genus (with *Keratinophyton*, which he considered a synonym) in the Cephalothecaceae, presumably on the basis of the membranous peridium. This family has penicillate phialoconidia and is not appropriate for*Aphanoascus*. Malloch (1981b) placed the genus in the Onygenaceae.

Udagawa and Takada (1973) neotypified Zukal's name *Aphanoascus cinnabarinus* with a eurotialean fungus which has a *Paecilomyces* anamorph and ascospores with dagger-like spines (see Fig 41d). On the basis of this neotype, Benny and Kimbrough (1980) placed *Aphanoascus* in the Trichocomataceae. Since these features differ from Zukal's protologue, and since Zukal's type is available (Apinis, 1968), Udagawa and Takada's neotype cannot be accepted.

Aphanoascus canadensis Currah*sp. nov.*

Typus: HOLOTYPUS (cultura desiccata). **UAMH** *4574 (fimo carnivora, Albertensis).*

Ascocarpi ferruginei, globosi, <800um. Ascosporae luteae, levae aut cum foveis minutis, oblatae, 2.5-3.1 x 3.8-4.2um. Asci globosi aut late ellipsoidi. Hyphae peridii membranaceae, cellulae irregularis, ferrugineae. Stat. conid. aleurioconidia et arthroconidia alterna, cylindracea, aliquando globosa 1.9-3.9 x 3.3-9.1um. In cultura: CER 38/25°C coloniis cum mycelio aerio sparso albo, pigmentum diffluens aurantiaco-tangerinum; reverso aurantiaco. OAT, ascoma i ferruginei abundans.

Aphanoascus canadensis sp. nov.

Figs 39a,b,c 43a,b

Type material: HOLOTYPE (*cultura desiccata*) **UAMH** 4574 (carnivore dung, Alberta).

Ascomata: reddish brown, globose, <800*u*m diam. **Ascospores:** yellow, finely reticulate, oblate, 2.5-3.1 x 3.8-4.2*u*m. **Asci:** globose to ellipsoid, 8-11*u*m maximum. **Peridial hyphae:** membranous layer of irregular polygonal cells, some elongated. **Anamorph:** alternate arthroconidia and aleurioconidia, 1.9-3.9 x 3.3-9.1*u*m; intercalary cylindrical conidia sometimes becoming globose. **In culture:** [UAMH 4574]. CER 38/25°C golden orange, tangerine, diffusible pigment with zonate aerial overgrowth of sparse hyaline mycelium; reverse orange. DSA 44/25°C hyaline white growth in the vicinity of hair; reverse uncolored. OAT 49/25°C abundant production of cleistothecia beneath cottony tomentum of vegetative hyphae. PYE 38/25°C cream to pale tan, deep cottony to felty; reverse pale yellowish tan.

Notes: This species is distinguished from *Aphanoascus fulvescens* on the basis of the finely sculptured ascospores, much smaller conidia, and the striking differences exhibited in culture.

Material examined: UAMH 4574 holotype as cited and type strain as cited.

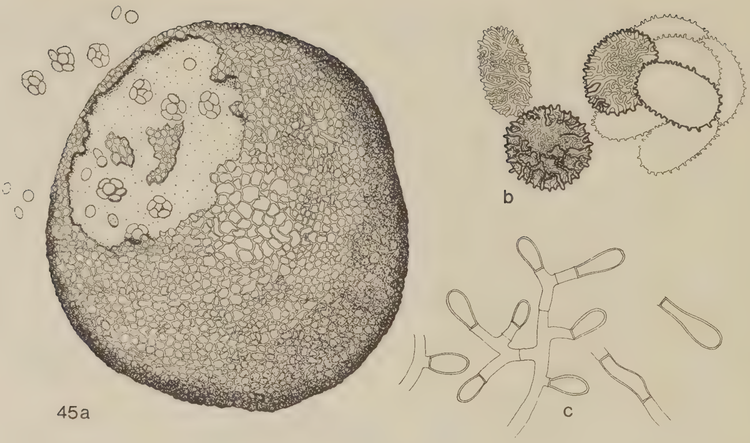
Aphanoascus fulvescens (Cooke) Apinis, 1968 Mycopathol. et Mycol. Appl. 35:101.

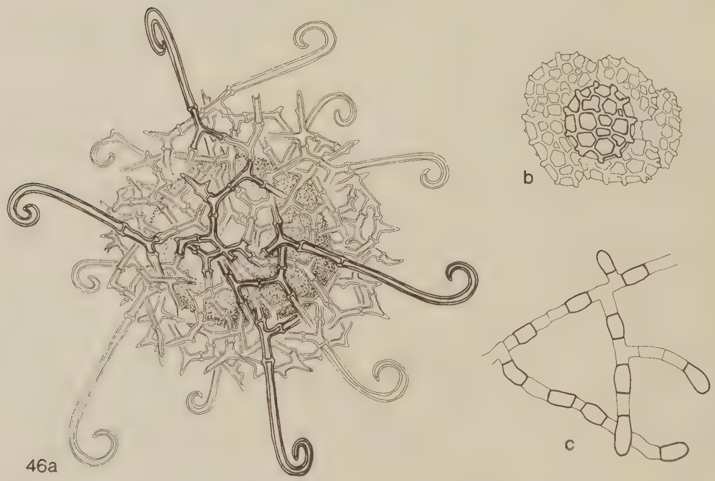
Figs 41c 44a, b,c,d,e,f 45a,b,c

Type material: K M. C. Cooke ("*Badhamia fulvescens*, Dupplin, Perth, England." *fide* Apinis, 1968)

≡*Badhamia fulvescens* Cooke, Grevillea 4:9, 1875.

≡*Eurotium fulvescens* (Cooke) Cooke, 1879.





Figs 45-46. 45. *Aphanoascus fulvescens* (UAMH 4603). a. Ascoma (cleistoperidium) with membranous wall. X210. b. Ascospores and ascus; ascospores look "spiny" as a result of the dense arrangement of irregular pits. X1745. c. Anamorph of solitary aleurioconidia, long- or short- pedicellate, pyriform with a truncate base. X685. 46. *Auxarthron californiense* (RSA 1525). a. Ascoma with uncinate appendages with pronounced knuckle joints. X255. b. Ascospores with broad pits; appearing reticulate. X3020. c. Anamorph of intercalary and terminal conidia. X1025.

≡*Anixiopsis fulvescens* (Cooke) de Vries, 1969.
=*Eurotium stercorarium* Hansen, 1876.
≡*Anixiopsis stercoraria* (Hansen) Hansen, 1897.
≡*Anixiopsis fulvescens* var. *stercoraria* (Hansen) de Vries, 1969.
=*Aphanoascus cinnabarinus* Zukal, 1890.
non *Aphanoascus cinnabarinus sensu* Udagawa and Takada, 1973.
=*Anixiopsis reticulospora* Routien, 1967.

Ascomata: yellow-brown, becoming dark brown, 100-400*u*m diam. **Ascospores:** yellow-brown, ovoid, irregularly punctate and ridged, appearing spiny with LM, 4-5.5 x 5-8.5*u*m. **Asci:** globose to subglobose, thin-walled, 8-spored, 8.5-13*u*m. **Peridial hyphae:** flattened cells in layers, outer layer thick-walled. **Anamorph:** *Chrysosorium* aleurioconidia solitary, long or short pedicellate or sessile; pyriform with a truncate base, hyaline, smooth to sparsely roughened, 7-8 x 10-12*u*m, occasionally 1-septate; sometimes forming globose "chlamydospores." **In culture:** [UAMH 4603]. CER 20/25°C creamy buff, felty to granular; reverse very pale orange. DSA 42/25°C creamy white, abundant, floccose mycelium with numerous reddish brown ascomata; reverse hyaline. PYE 21/25°C buff yellow, concentrically zonate with pale tan, densely felty; reverse yellow to pale brown.

Material examined: as *Anixiopsis* sp.: **TRTC** O-582/coyote dung/California; 32272/dog dung/Ontario; O-583/sheep dung/California; as *Anixiopsis stercoraria*: **UPS** Feurich/fox dung/Germany (natural material); **S** Feurich/cat dung/Germany (natural material); **TRTC** O-870/?/?; 36885/Ontario; 33516, C317/bear dung/Ontario; 43978, 43979/carnivore dung/Ontario (natural material); 40388/carnivore dung/Massachusetts (natural material); 45246/carnivore dung/Nova Scotia (natural material); Cain, 19196/cow dung/Nebraska (natural material); 6604, 12398/dog dung/Ontario (natural material); 34044, 35716, 31641/dung/Ontario; 37242/fox dung/Ontario; Cain 697/fox dung/Quebec; Watling 47/kestrel pellet/England; **E** Watling 6024/sheep dung/Scotland; **TRTC** 32680, 38504/fox dung/Ontario; **S** Feurich/fox dung/Germany; **UPS** Nordin/fox dung/Sweden; **TRTC** 64-T-56-1 (*cultura desiccata*); 64-c-24-2/soil/Japan (*cultura desiccata*); 44886/weasle dung?/Ontario (natural material); as *Aphanoascus fulvescens*: **NY** CBS 111.58/bear dung/Canada; **TRTC** 43979/?/?; 6482/badger dung/Germany (natural material); 40142/cow dung/Idaho (natural material); 37710/fox dung/Argentina (natural material); Warcup A282/2/soil/Australia; 12397/bear dung/Ontario (natural material); 45329/carnivore dung/Ontario (natural material); 31323/fox dung/Ontario (natural material); 7686/dog dung/Ontario (natural material); **UAMH** 4603/dung/Alberta, coll. Currah.

APINISIA La Touche, 1968

Trans. Brit. mycol. Soc. 51:283.

Type species: *Apinisia graminicola* La Touche.

Ascomata: white, globose, c. 200*u*m diam. When aggregate, globose to ovoid, up to 7000*u*m in diam. excl. appendages; **Ascospores:** yellow, globose with finely echinulate walls, 2.2-3.6*u*m diam. **Asci:** globose to subglobose, 5.7-7.6*u*m diam. **Appendages:** large pedicellate, septate, thick-walled, hyaline helical hypha 3.8*u*m wide, sometimes with tubercles; when tightly wound 26.6-34.4*u*m wide, up to 300*u*m long, emerging from the cleistoperidium. **Peridial hyphae:** hyaline, septate, thick-walled, branched, unequal, straight, curved or sinuate, smooth or rarely echinulate, forming an incompositoperidium. **Ascocarp initials:** very short, irregular hyphae, some of which are branched once forming coils as they increase in size and forming tangled clumps. **Anamorph:** aleurioconidia - pyriform or clavate but occasionally irregular, lateral or terminal, 3.8-6.5 x 0.95-2.7*u*m and also intercalary conidia which are rectangular or irregular and about 1.9-3.8*u*m, in chains.

Notes: Cleistothecia bear a superficial resemblance to those of *Shanorella spirotricha* (Benjamin, 1956) in that the peridiam. in both species are ultimately reduced to a mass of disunited, thick-walled cells.

Apinisia graminicola La Touche, 1968 Trans. Brit. mycol. Soc. 51:283-285 FIG 1-19.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** 126422 (rotting grass, England).

Ascomata: white, globose to ovoid, 200-700*u*m diam., excl. appendages. **Ascospores:** yellow, ochraceous in mass, globose, wall finely echinulate, 2.2-3.6*u*m diam. **Asci:** globose to subglobose, thin-walled, 5.7-7.6*u*m diam. **Peridial hyphae:** hyaline, septate, thick-walled, branched, unequal, straight, curved or sinuate, smooth or echinulate, disarticulating, 2-15 x 10-40*u*m. **Appendages:** hyaline, pedicellate(?), septate, thick-walled, helical hyphae, 3.8*u*m in diameter, sometimes tuberculate, up to 300*u*m long. **Anamorph:** *Chrysosporium* state, aleurioconidia pyriform or clavate or irregular, lateral or terminal, 1-2.7 x 3.8-6.5*u*m, intercalary spores rectangular or irregular 1.9-3.8*u*m in chains. **In culture:** [UAMH 4315]. CER 50/25°C pale yellowish, thin, sulcate; reverse pale yellow, (numerous helices formed). DSA pale yellow white, dense, appressed to medium; reverse white. PYE 35/25°C cream, yellow to white, thick, densely felty, buckling; reverse concolorous.

Notes: La Touche indicates that this species is intolerant of high temperatures (will not grow at 27°C). Since the strain in UAMH has not fruited, I have taken the above description largely from the original.

ASCOCALVATIA Malloch and Cain, 1971
Can. J. Bot. **49**:840.

Type species: *Ascocalvatia alveolata* Malloch and Cain

Ascomata: white, nonostiolate, subglobose to globose, large ("small puffballs"). **Ascospores:** cylindrical to slightly allantoid, hyaline 2-3 x 4-5.5*u*m. **Asci:** subglobose to globose, 8-spored. **Appendages:** lacking. **Peridial hyphae:** thick, 2-layered. **Centrum characteristics:** sterile elements long, thickened on one side ("elators"). **Anamorph:** arthroconidia. **Degrades:** keratin.

Notes: This genus has some similarities to *Onygena* in ascospore shape and the stromatic nature of the fruit bodies.

Ascocalvatia alveolata Malloch and Cain, 1970 Can. J. Bot. 49:840.

Type material: HOLOTYPE (*cultura desiccata*) **TRTC** 45318 (carnivore dung, Ontario).

Ascomata: white, yellowish with age, 1-5mm diam., subglobose to globose, solitary. **Ascospores:** hyaline, cylindrical to slightly allantoid, smooth, 2-3 x 4-5*u*m. **Asci:** 6-8*u*m diam., separated by bands of sterile tissue, sterile hyphae 2-3.5*u*m wide. **Peridial hyphae:** pale yellow, membranous, 25-70*u*m thick. **Anamorph:** smooth, hyaline arthroconidia, 2-3 x 3.5-10.5*u*m, mostly nonseptate, occasionally 1-3 septate.

Notes: Known only from the type.

Material examined: **TRTC** Holotype as cited.

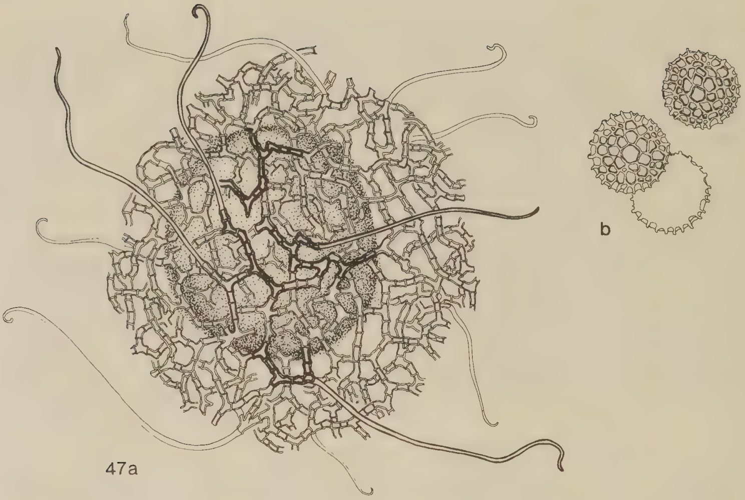
AUXARTHRON Orr and Kuehn, 1963
Can. J. Bot. **41**:1439.

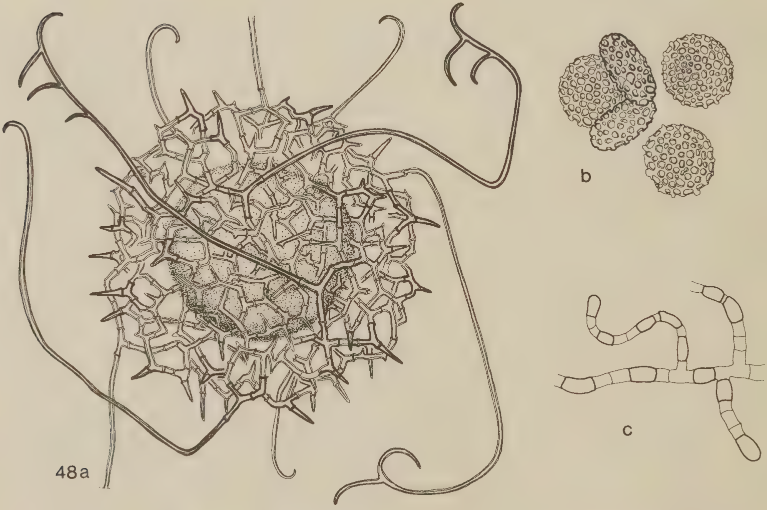
Type species: *Auxarthron californiense* Orr and Kuehn =*Macronodus* Orr, 1977.

Ascomata: yellow-brown or orange-brown, to cinnamon to reddish brown, globose, <700*u*m diam.; reticuloperidium. **Ascospores:** hyaline or yellow or yellow-brown, spherical or oblate, minutely punctate to punctate-reticulate, appearing echinulate to reticulate, <5*u*m. **Asci:** hyaline, subglobose or globose or obovoid, evanescent, 7.2-8 x 10.6*u*m. **Peridial hyphae:** reddish or rusty or tan, enlarged at septa, thick, cuticularized, smooth to minutely to coarsely asperulate or tuberculate. **Appendages:** usually present, septate, asperulate, branches rare, tips round, subacute or acute; longer appendages septate with simple apices which are straight, bent, slightly coiled or uncinate. **Anamorph:** aleurioconidia and arthroconidia hyaline or light-colored, terminal, intercalary or rarely lateral, pyriform, oblong or cylindrical, variable in size. **Degrades:** keratin

Notes: This is a striking and beautiful group of ascomycetes with elaborate orange to reddish brown ascomata. Early isolates of taxa now assigned to *Auxarthron* were generally assigned to *Gymnoascus* or *Myxotrichum*, on the basis of the peridial structure and appendages. Both Apinis (1964) and Udagawa (1966) continued to consider species of *Auxarthron* in *Gymnoascus* even following Orr *et al.*'s, (1963a) pioneering monograph of the genus. Orr *et al.* first distinguished the species of *Auxarthron* from *Gymnoascus* on the basis of the presence of wall thickenings in the vicinity of septa which they called "knuckle joints." While these are common features of species of *Auxarthron*, knuckle joints also occur in *Gymnoascus reessii*, as well as in other taxa with reticuloperidia. The main generic distinction to note is the presence of shallow puncta on the walls of the ascospores which are borne in very elaborate reticuloperidia. The separation is further supported by anamorph morphology and degradative capacities.

Auxarthron is usually quite easy to identify although, as





Figs 47-48. 47. *Auxarthron compactum* (NY O-573). a. Ascoma with short, broad, thick-walled peridial cells. X235. b. Oblate, punctate-reticulate ascospores. X3760. 48. *Auxarthron conjugatum* (NY O-520). a. Ascoma showing reticuloperidium of thick-walled cells, and long appendages, some with bifurcate tips. X240. b. Finely punctate-reticulate, oblate ascospores. X3230. c. Arthroconidia on lateral, arcuate branches. X665.

mentioned under *Amauroascus*, distinguishing these two genera can be difficult (see *Amauroascus kuehnii* and *Amauroascus pseudoreticulatus*). Species in *Auxarthron* are distinguished from each other primarily on the basis of shape and size of ascospsores. Particular attention must be paid to the pattern of puncta including size and number of pits. Shape of appendages and cells of the peridium are also important characters to consider. Slide cultures of anamorphs are useful if pure living cultures are available. Difficulties in using anamorphs as sources of taxonomic criteria arise when materials available are dried or are on natural substrata.

Auxarthron is a saprophyte found frequently on dung and in soil from the entrances of animal burrows. The genus is probably worldwide in distribution, but much more collection and isolation work is required.

Auxarthron californiense Orr and Kuehn, 1963 Can. J. Bot. 41:1442-1443 FIG 1-2.

Figs 46a,b,c 51a,c 52a,c 56a

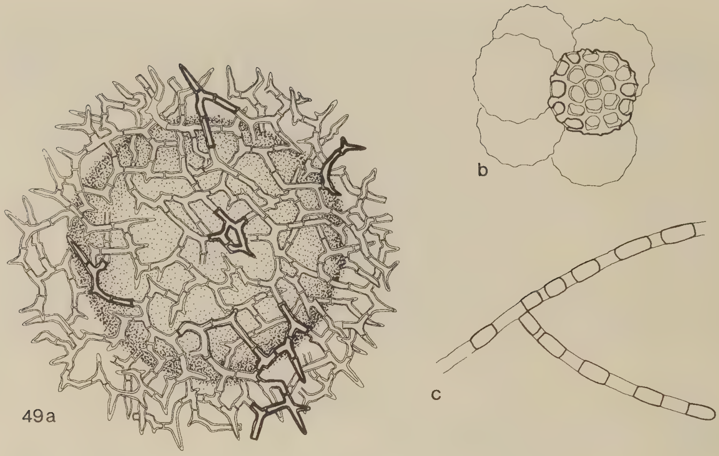
Type material: HOLOTYPE (*cultura desiccata*) **NY** O-908 (pack rat dung, California).

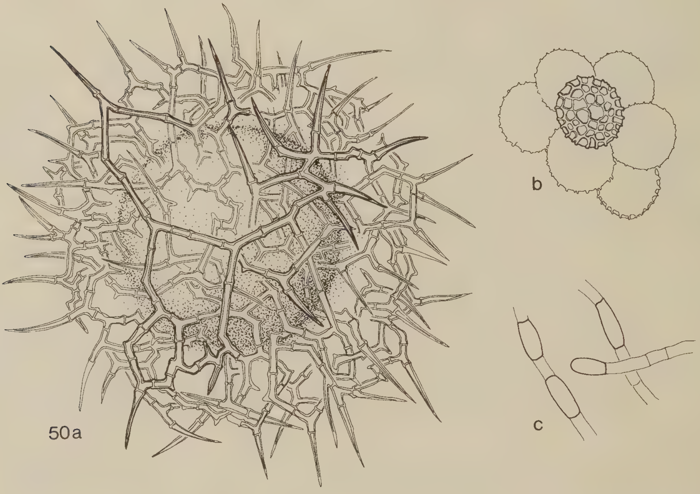
≡*Gymnoascus californiensis* (Orr and Kuehn) Apinis, Mycol. Pap. **96**:12, 1964.

Ascomata: rosy when young, orange to brown at maturity, 130-450*u*m diam. excl. appendages. **Ascospores:** pale yellow-brown or hyaline, oblate, broadly punctate to appear reticulate (appearing echinulate at margin) 3.2-4 x 3.2-4.8*u*m. **Asci:** ±globose, to 10.6*u*m diam. **Peridial hyphae:** pale orange-brown, thick-walled, asperulate, cuticularized, anastomosed, septate, knuckle-joints to 6.4-9.6*u*m wide, apices short, spine-like, asperulate, rounded or blunt, 9.6-26*u*m in length. **Appendages:** orange-brown, smooth, straight to curved/bent, occasionally branched with basal knuckle-joints, apices uncinate, 72-375*u*m in length (about the diam. of the ascoma). **Anamorph:** conidia pale orange, terminal, intercalary, smooth to minutely rugose, 2-2.5 x 3.5-6*u*m. **In culture:** [UAMH 1889]. CER 28/25°C camel-colored with faint pale orange cast, thick and velvety; reverse rosy tan. DSA 42/25°C abundant rust-brown ascomata on sparse, hyaline vegetative mycelium; reverse uncolored. PYE 28/25°C velvety, heaped, luxurious, cream to pale yellowish; reverse yellow-tan.

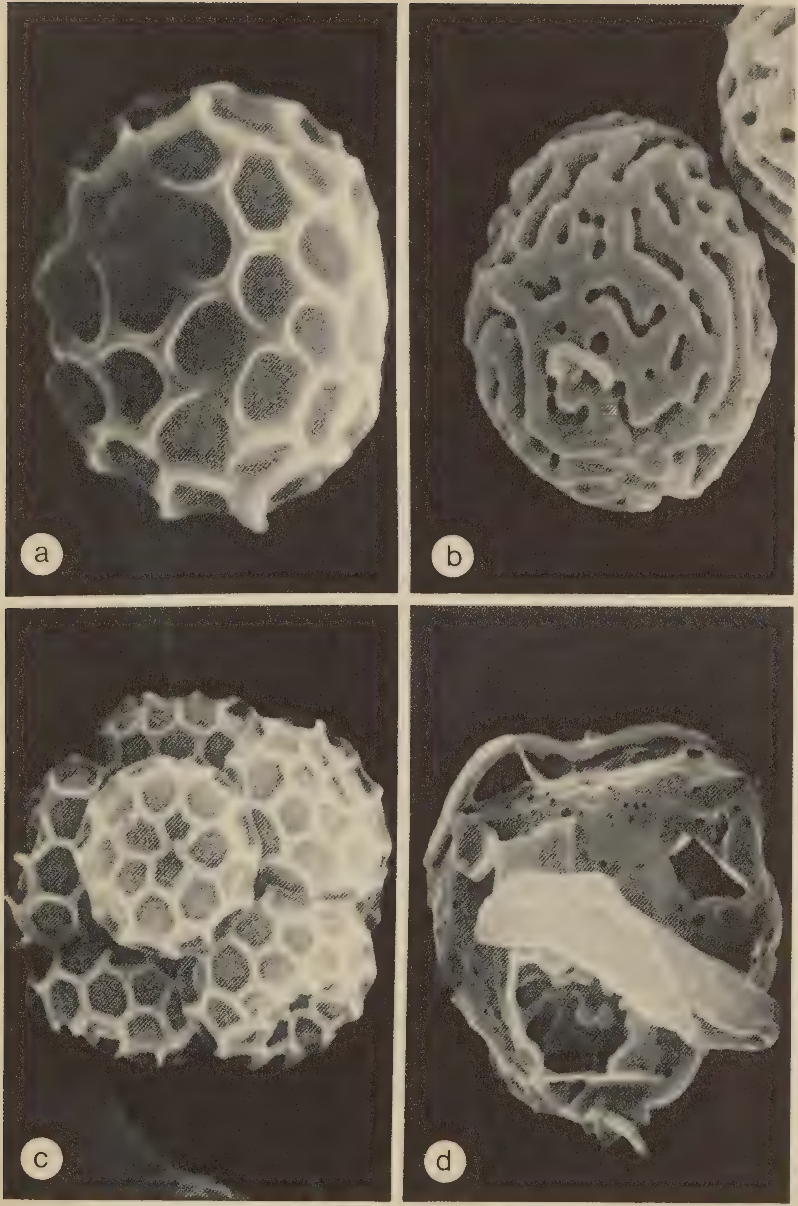
Notes: This very distinct species is superficially similar to *Uncinocarpus uncinatus*, but is easily distinguished on size and appearance of ascospores. The two share thick-walled, uncinate appendages, but the crozier-shaped tips of *Auxarthron californiense* taper to an acute end while the tips of the other remain parallel and have blunt termini. Apinis (1964) examined collections of this taxon on the fungus *Scleroderma vulgare*, cellophane which had been buried in a calcareous fen, and bird dung.

Material examined: RSA 1525 (=NRRL A-11,022, =UAMH 1591, 1889, 3151, =NY O-908) (type strain as cited); 1241 (=UAMH 3111)/dung/California; 1262/dung/Oregon; **E** Watling 4050/rabbit dung/Scotland; as *Gymnoascus californiensis*: **BP** 54228/deer dung/Hungary.





Figs 49-50. 49. *Auxarthron reticulatum* (UAMH 1585). a. Ascoma showing reticuloperidium of thick-walled cells. X290. b. Globose, punctate-reticulate ascospores in ascal cluster. X4075. c. Anamorph of intercalary and terminal conidia. X755. 50. *Auxarthron zuffianum* (RSA 517). a. Reticuloperidium with short, spine-like, straight to curved appendages. X375. b. Globose to subglobose, punctate-reticulate ascospores showing polygonal arrangement in ascal cluster. X3445. c. Cylindrical or oblong arthroconidia. X705.


a
b
c
d

Auxarthron compactum Orr and Plunkett, 1963 Can. J. Bot. **41**:1453-1454 FIG 24-25.

Figs 47a,b,c 53a 55d

Type material: HOLOTYPE (*cultura desiccata*) **NY** O-573. (rat dung, California).

Ascomata: brown, spherical, 310-675um diam., excl. appendages. **Ascospores:** hyaline to pale tan, oblate, 2.4-3.6um, reticulate-echinulate. **Asci:** ±globose, 6.5-9um diam. **Peridial hyphae:** pale orange brown, finely to roughly asperulate, thick-walled, apices few, blunt, short, spine-like, septate, individual cells short and broad, knuckle joints 3.6-5.4um diam. **Appendages:** orange-brown, fading to tip, one basal knuckle-joint, 350-600um in length, slightly bent to coiled apically. **Anamorph:** arthro and aleurioconidia, hyaline to pale yellow and variable in size. **In culture:** [UAMH 3153]. CER 35/25°C sparse, zonate, pale creamy ochre with mounds of discrete ascomata; reverse orange-brown. DSA 42/25°C sparse, pale yellowish white with numerous brown ascomata; reverse pale yellow. PYE 56/25°C wrinkled, rugose, ochre-brown; reverse red-brown.

Notes: This species is distinguished from others in the genus on the basis of the short, squat, thick-walled cells of the peridial hyphae.

Material examined: NY, RSA, UAMH (type as cited); **UAMH** 3152 (=O-36)/kangaroo rat lung/California; 3153 (=RSA 1527) /rat dung/California; as *Gymnoascus zuffianus*: **UPS** Gunnerbeck/roe dung/Sweden.

Auxarthron conjugatum (Kuehn) Orr and Kuehn, 1963 Can. J. Bot. **41**:1452-1453 FIG 22-23.

Figs 1e 48a,b,c 53c,d 54a,c 55e 56b

Type material: HOLOTYPE (*cultura desiccata*) **NY** O-520 (soil, Arizona).

≡*Myxotrichum conjugatum* Kuehn, Mycologia **47**:883, 1955 (Basionym).

=*Macronodus bifurcatus* Orr, Mycotaxon 5:284, 1977.

≡*Gymnoascus bifurcatus* (Orr) Von Arx, 1981 (page 132).

Anamorph name: *Malbranchea* state of *Auxarthron conjugatum*, *fide* Sigler and Carmichael, 1976.

Ascomata: pale orange or yellow-brown, spherical, 235-540um, excl. appendages. **Ascospores:** hyaline to pale tan or yellow-orange, oblate, finely punctate-reticulate, 1.8-2.5 x 2.5-3.8um. **Asci:** hyaline, ellipsoidal, obovoid, 4.2-5 x 6.8-8.2um. **Peridial hyphae:** pale yellow or orange-brown, smooth to asperulate, thick-walled, 2.6-3um wide, septate knuckle-joints 3.2-6um wide, apices spine-like, asperulate, rounded to acute, 9-96um in length.

<---Fig. 51. a. *Auxarthron californiense* (UAMH 3151). Oblate, punctate ascospore. X20520. b. *Neogymnomyces demonbreunii* (UAMH 3382). Thick-walled, oblate-ovoid ascospore with irregular, elongated pits. X14040. c. *Auxarthron californiense* (UAMH 3151). Conglobate cluster of oblate ascospores. X10080. d. -*Amauroascus reticulatus*- (UAMH 3560). Sheathed ascospore. X13680.

Appendages: orange to red-brown, fading to apex, occasionally with small, terminal dichotomies or branches, nonseptate straight, bent, hooked, coiled, 2.8-3.2 x 226-1550*u*m. **Anamorph:** hyaline to pale yellow, terminal or intercalary, on lateral, curving branches 1.2-1.5 x 2.5-5*u*m or 3 x 3-5 when borne on main hypha (these becoming subglobose with age). **In culture:** [UAMH 3156]. CER 35/25°C ochre in central region, surrounded by yellow-ochre, powdery texture; DSA 112/25°C numerous brown ascomata with a few patches of thick, creamy white mycelium; reverse uncolored. PYE 28/25°C cottony growth over coffee-brown mat; reverse wine red.

Notes: A detailed discussion of the anamorph is presented in Sigler and Carmichael (1976). *Macronodus bifurcatus* was described by Orr (1977) as a somewhat similar fungus which differed on the basis of the branching pattern of the appendages and sculpturing on the ascospores. Orr reported that the ascospores were smooth. The types of the two taxa appear identical to me. Ascospores are identical by SEM. Von Arx (1981) recognized the taxon as *Gymnoascus bifurcatus*.

Auxarthron conjugatum is similar to *Auxarthron umbrinum* which in not having bifurcate appendages, and having minutely punctate ascospores which are more broadly oblate.

Material examined: **NY** O-532/?/?; O-789/kangaroo rat lung/California; O-948/lizard dung/California. **RSA** 1474, 1475 (=UAMH 3130)/lizard dung/Mexico; as *Gymnoascus* sp.: **TRTC** Cooke, 1999/creek sediment/Ohio; **UAMH** 3156 (type as cited), from RSA as RSA 1530; 3519/soil/Sudan; 3817 (=O-1236)/soil on horn/India; 3841 (=O-3153) feathers/Queensland; 3874 (=O-3750)/soil/Kansas (type of *Macronodus bifurcatus*); 161 (Emmons A-4718)/rodent lung/Texas.

Auxarthron pseudauxarthron Orr and Kuehn, 1972 Mycologia **64**:67 FIG 13-15.

Figs 53b,e 55c

Type material: HOLOTYPE (*cultura desiccata*) **NY** O-3083 (rabbit dung, Utah).

Ascomata: yellow or yellow-brown, spherical, 220-650*u*m diam. (incl. appendages). **Ascospores:** hyaline to pale yellow, spherical, 2.3-3.2*u*m diam., finely punctate-reticulate. **Asci:** ±globose, to 11.4*u*m diam. **Peridial hyphae:** forming a lax, open network, yellow-brown or brown, septate, walls thick, finely asperulate, cells elongate. **Appendages:** yellow-brown, lacking knuckle-joints, 40-110*u*m long, smooth/finely asperulate with rounded apices. **Anamorph:** not observed. **In culture:** [UAMH 3404]. CER 40/25°C greenish in central area, perimeter white; reverse pale green. DSA 49/25°C yellowish tan; reverse pale yellow. PYE 40/25°C white, cottony, concentrically zonate with greenish tinge in central area; reverse brown (to almost black) in centre grading to tan at perimeter.

Notes: Easily identified on the basis of ascospore morphology and the long cells of the lax, open reticuloperidium. This is the only *Auxarthron* species for which an anamorph has not been recorded.

Material examined: **UAMH** 3404 (type strain as cited).

Auxarthron reticulatum (Zukal) Orr and Plunkett, 1963 Can. J. Bot. 41:1443-1445.

49a,b,c 52b 54d 55f 56e

Type material: NEOTYPE (*cultura desiccata*) **NRRL** A10748. (wood slat from greenhouse flat, California).

≡*Gymnoascus reticulatus* Zukal, Verh. Zool. Bot. Ges. Wien 37:40, 1887 (Basionym).

Ascomata: rosaceous when young, becoming dark brown or brownish with yellow, orange, or red overtones, 90-400*u*m diam. incl. appendages. **Ascospores:** hyaline to pale yellow, globose, 2.2-3.6*u*m diam., reticulate-echinulate. **Asci:** ±globose, 8.2-12.2*u*m diam. **Peridial hyphae:** yellow-brown, thick-walled, asperulate, septate, knuckle-joints 3.2-5.6*u*m wide free apices truncate. **Appendages:** short, spine-like, asperulate, blunt, rounded, slightly subacute, 6-35*u*m. **Anamorph:** hyaline to pale yellow, terminal and intercalary, 2-3 x 2.5-6*u*m. **In culture:** [UAMH 1585]. CER 21/25°C even textured white mat, ascomata abundant in central area; reverse yellow. PYE 21/25°C yellowish cream, abundant heaped zonate to sulcate growth; reverse orange chestnut.

Notes: Orr stated there were some doubts regarding the accurate usage of Zukal's name, since Zukal described the ascospores as being larger (6.4*u*m), and ellipsoid to lenticular. The presence of swollen septal regions in the hyphae of the peridium supported the transfer of the species to *Auxarthron*. Some collections received during this study, as *Arachniotus reticulatus* and *Auxarthron reticulatum*, actually represented species of *Amauroascus* based on the deep puncta of the ascospores. I have been able to place these in either *Amauroascus kuehnii* or *Amauroascus pseudoreticulatus*.

Material examined: RSA 1528 (=UAMH 1585, 1659, 3154) neotype strain as cited; 1438, 1439, 1490/lizard dung/Mexico.

Auxarthron umbrinum (Boudier) Orr and Plunkett, 1963 Can. J. Bot. 41:1446-1449 FIG 9, 13-19.

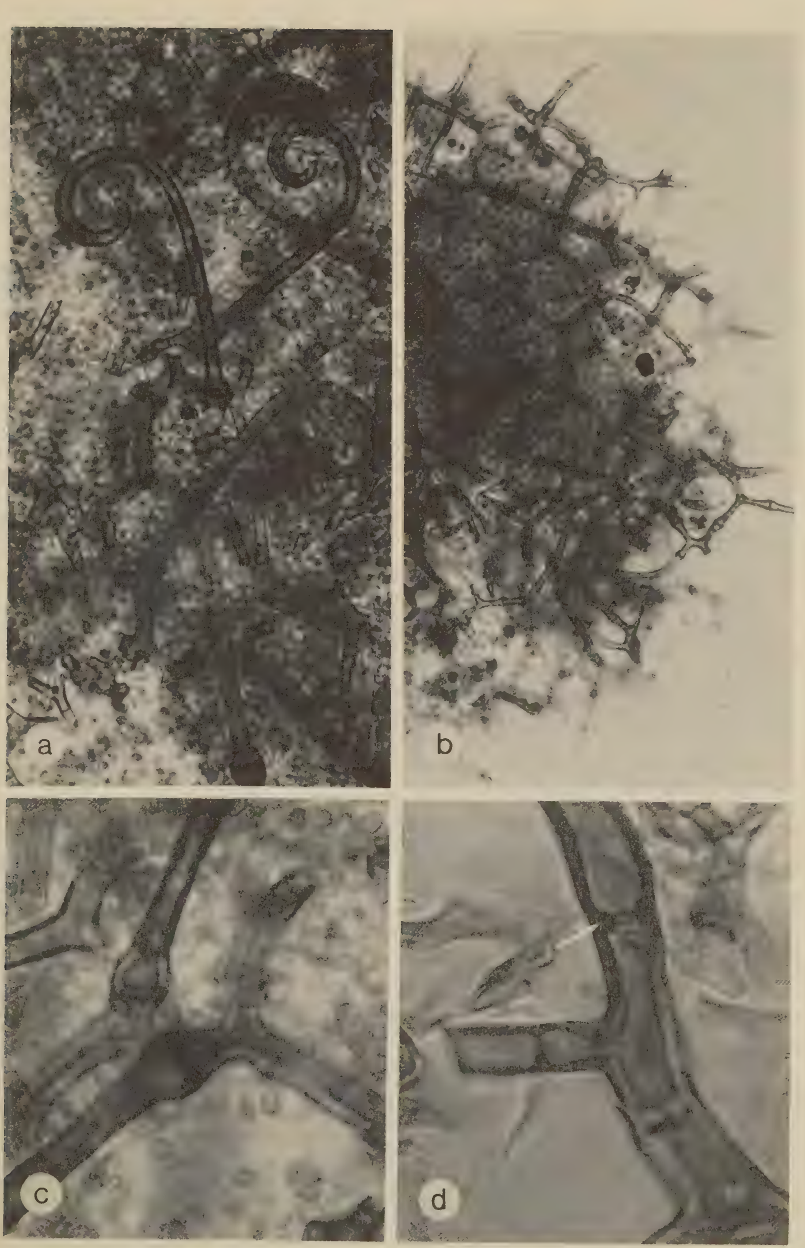
Figs 54b, 56d

Type material: HOLOTYPE strain(?) **CBS** O-1030 (obtained from the Pasteur Institute, Paris and thought to be Boudier's original strain, no collection data available but probably from France).

≡*Gymnoascus umbrinus* Boudier, Bull. Soc. Mycol. Fr. 8:43, 1892.

=*Myxotrichum brunneum* Rostrup, Bot. Tidssk. 19:206, 1895.

Fig. 52. a. *Auxarthron californiense* (RSA 1525). Thick-walled, uncinate peridial appendages with enlarged basal septum (knuckle-joint). X680. b. *Auxarthron reticulatum* (RSA 1528). Ascoma with organized reticuloperidium of thick-walled hyphae. Appendages short and blunt. X240. c. *Auxarthron californiense* (RSA 1525). Y-shaped configuration of peridial element giving rise to uncinate appendage. X900. d. *Uncinocarpus uncinatus* (FH hen dung). Septum (arrow) at base of uncinate appendage. Compare with Fig 52c. X1350.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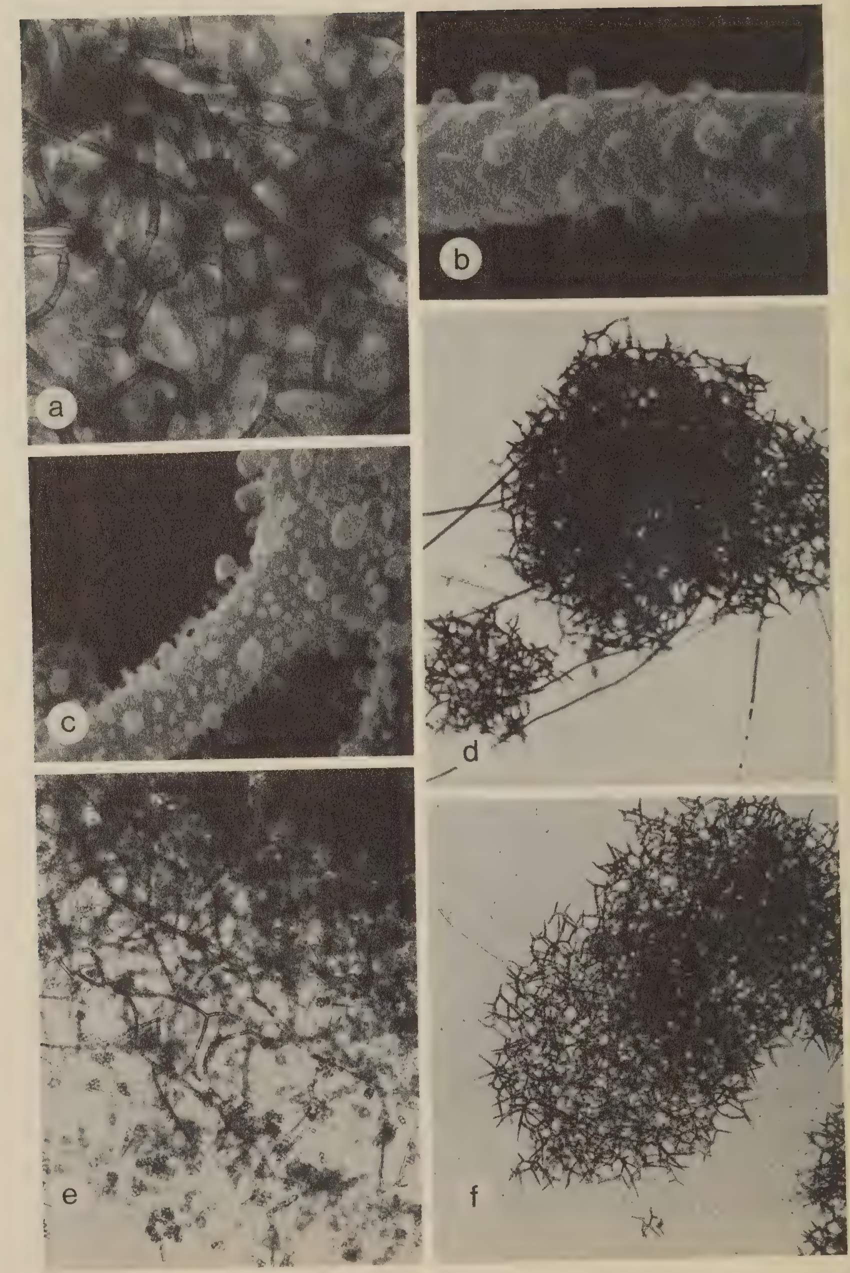
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≡*Auxarthron brunneum* (Rostrup) Orr and Kuehn, Can. J. Bot. **41**:1446, 1963.
=*Gymnoascus subumbrinus* Smith, Trans. Brit. mycol. Soc. 5:424, 1917.
=*Myxotrichum emmonsii* Kuehn, Mycologia **47**:539, 1955.
?=*Myxotrichum thaxteri* Kuehn, Mycologia **47**:878, 1955.
≡*Auxarthron thaxteri* (Kuehn) Orr and Kuehn, Mycologia **63**:200, 1971.

Ascomata: light to dark brown or red-brown, spherical, 180-600μm excl. appendages. **Ascospores:** yellow to pale brown, finely punctate-reticulate, oblate, 1.8-3.2 x 2-4.2μm. **Asci:** ±globose, to 10μm maximum. **Peridial hyphae:** yellow-brown to brown, smooth to asperulate, septate, knuckle joints to 9.6(-16)μm diam., anastomosed, free apices spine-like, asperulate with rounded apices, 3.8-56μm, adjacent spines may anastomose at base. **Appendages:** brown, paler toward apex, numerous, 2.7-3.3μm wide, nonseptate except at basal knuckle-joints, apices uncinate, straight bent, sinuate or coiled, 250-1350μm long. **Anamorph:** hyaline, terminal conidia pyriform; intercalary conidia variable, 1.2-3.6 x 2.8-9.6μm. **In culture:** [UAMH 3952]. CER 28/25°C concentrically zonate, some sectoring, fuzzy felty ochre-yellow, ascoma production in centre is heavy; reverse rich wine-red brown at centre fading to pale orange-yellow at margin. DSA 42/25°C white, densely felty; reverse uncolored. PYE 35/25°C rust-orange in centre paling to cream-yellowish white at margin, luxuriant cottony growth; reverse orange to reddish yellow.

Notes: Easily confused with *Auxarthron conjugatum*. A detailed comparative study of the two species is required. At present, they are distinguished on the basis of size and ornamentation of the ascospores: *Auxarthron conjugatum* has slightly larger and more coarsely punctate ascospores than *A. umbrinum*. Appendages of *A. conjugatum* are frequently branched or bifurcate, while those of *A. umbrinum* are simple.

Material examined: FH Thaxter 599/*Isaria farinosa*/Massachusetts. **NY** B30/soil/England; O-236, -310/soil/California; O-561/lizard dung/California; O-832/?/CDC Georgia; O-901/pine forest soil/England; O-1023/soil/England; O-1027/pack rat lung/Texas; O-3168/lab contaminant/Utah. **RSA** 54/dung/Illinois; 82/dead beetle/California; 413/lizard dung/Haiti (type of

Fig. 53. a. *Auxarthron compactum* (NY O-573). Reticuloperidium composed of short, broad, thick-walled cells. X375. b. *Auxarthron pseudauxarthron* (UAMH 3404). Fine asperulations on hypha of reticuloperidium. X15840. c. *Auxarthron conjugatum* (UAMH 3874). Coarse, asperulations on hyphae of peridium. X4680. d. *Auxarthron conjugatum* (NY O-532). Reticuloperidium with long appendages. X110. e. *Auxarthron pseudauxarthron* (UAMH 3404). Lax, open reticuloperidium of slender, elongated cells. X180. f. *Auxarthron zuffianum* (NY O-514). Reticuloperidium with numerous short, needle-like appendages. X110.

Myxotrichum thaxteri; 418/*Neotoma*/Texas; 1484/lizard dung/Mexico. **TRTC** CMI 41112/soil/England. **UAMH** 3952 from Orr as type strain; 4484/prairie dog dung/Alberta; 4784/dung/Alberta; 4814/coyote dung/Alberta.

Auxarthron zuffianum (Morini) Orr and Kuehn, 1963 Can. J. Bot. **41**: 1445-1446.

Figs 50a,b,c 53f 56c

Type material: NEOTYPE (*cultura desiccata*) **NY** O-514 (prairie dog lung, Texas).

≡*Gymnoascus zuffianus* Morini, Mem. R. Accad. Sci. Bologna IV 10:205, 1889 (Basionym).

=*Gymnoascus eidami* Cocconi, Mem. R. Accad. Sci Bologna V 2:32, 1891 *fide* Orr *et al*., 1963a.

=*Gymnoascus brevisetosus* Kuehn, Mycologia **48**:813, 1956 *fide* Orr *et al*. 1963a.

Ascomata: orange-brown to brown, 195-600 diam. incl. appendages. **Ascospores:** hyaline to yellow or yellow-brown, globose to subglobose, 2.4-3.6*u*m, punctate-reticulate. **Asci:** hyaline, obovoid, 5.6-7 x 7-8.4*u*m, 8-spored. **Peridial hyphae:** pale orange-brown, smooth to asperulate, thick-walled, cuticularized, dichotomously anastomosed, knuckle-joints 2.4-5.8*u*m wide, free apices form appendages. **Appendages:** pale orange-brown, short, spine-like, smooth to asperulate, straight or curved, occasionally bifurcate from the base, apices pointed 10-85*u*m long. **Anamorph:** terminal, pyriform aleurioconidia or intercalary, cylindrical or oblong arthroconidia, 2-5 x 3-8*u*m, sometimes becoming swollen and ±globose. **In culture:** [UAMH 1875]. CER 14/25°C snow-white, yellowish in centre, flat, felty to granular; reverse yellow. DSA 42/25°C yellowish white, reverse pale yellow. PYE 21/25°C white, thick and dense; reverse orange in centre, yellow at perimeter.

Notes: The long, acutely pointed spines, distinguish this species from *Auxarthron reticulatum* which has shorter, blunt spines. *A. zuffianum* is primarily coprophilous. I have found a similar species on coyote dung (Fig. 43c,d).

Material examined: NY O-514/ (=UAMH, 1875)/prairie dog lung/Texas; (type of *Gymnoascus brevisetosus*). O-608/kangaroo rat lung/California; O-3663/soil/Australia; DPG 99/sand/Utah. **RSA** 517/rabbit dung/California; 806/soil/Mexico; 1479 (=UAMH 3135),1487 (=UAMH 3142), 1504 (=UAMH 3150)/lizard dung/Mexico. **TRTC, UPS** Nordenstan/babboon dung/S. W. Africa. **UAMH** 3079 (=CMI 76603) soil/England; 4082 (=CDC Y-333), 4098 (=CDC Y-337),

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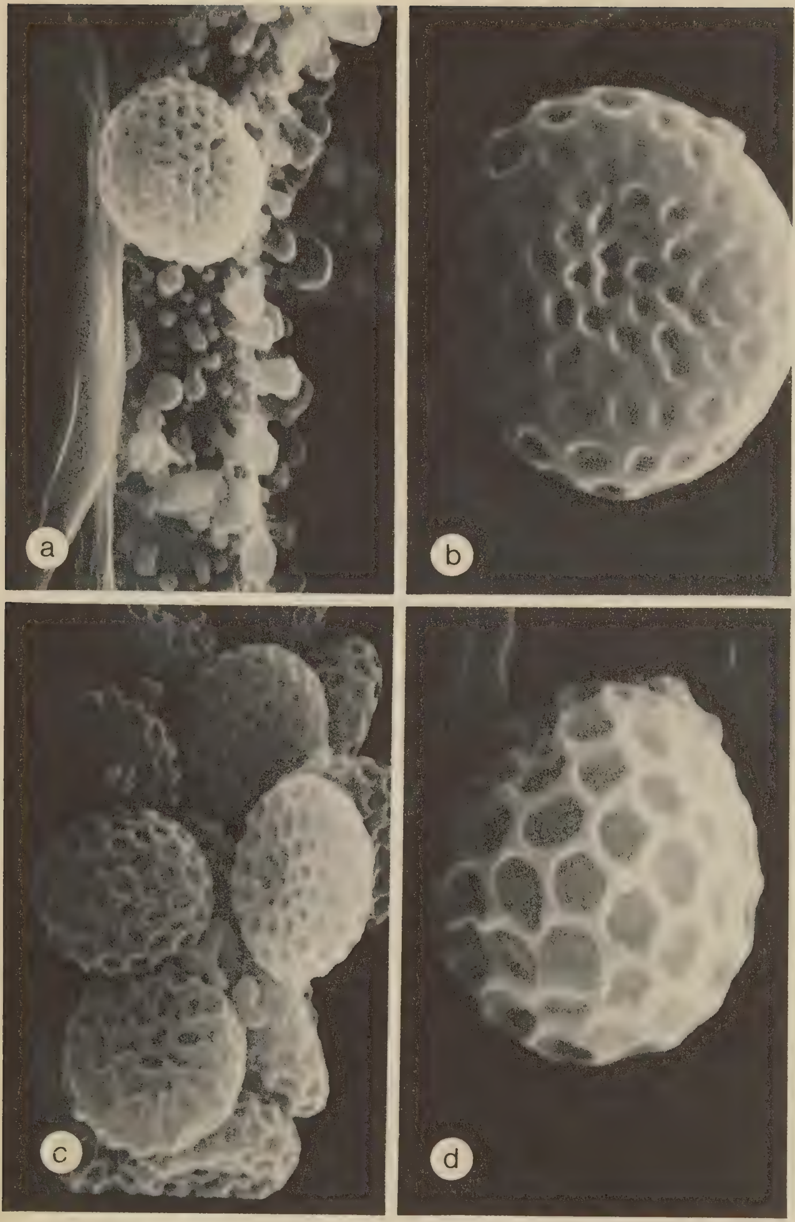
Fig. 54. a. *Auxarthron conjugatum* (UAMH 3874, type strain of *Macronodus bifurcatus*). Pitted ascospore and coarsely asperulate cell of peridium (cf. Fig. 54c). X9720. b. *Auxarthron umbrinum* (UAMH 3118). Ascospore with rounded, shallow puncta and wide punctum ridges. X16540. c. *Auxarthron conjugatum* (UAMH 3118, type strain). Cluster of oblate, reticulate ascospores. X10080. d. *Auxarthron reticulatum* (UAMH, 1877). Oblate ascospore with coarse, rounded, polygonal pits. X20160.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4566/soil/Argentina.

KERATINOPHYTON Randhawa and Sandhu, 1964
Sabouraudia 3:252.

Type species: *Keratinophyton terreum* Randhawa and Sandhu

Ascomata: light- to dark-brown, subglobose to globose, glabrous, nonostiolate. 270-670*u*m diam. **Ascospores:** light yellowish brown, smooth on the faces with a low irregular equatorial crest, 1.7-3.3 x 3.3-5*u*m. **Asci:** ovoid to globose, 4.2-6.7 x 6.7-8.4*u*m. **Appendages:** lacking. **Peridial hyphae:** flattened, reddish brown, polygonal cells forming a membrane. **Anamorph:** *Chrysosporium*-like; aleurioconidia borne at the ends of undifferentiated hyphae. **Degrades:** keratin

Notes: Apinis (1968) placed the type species in *Aphanoascus*, but these taxa are quite distinct. The ascospores of the two species included here in *Keratinophyton* each have a punctate equatorial band with smooth, broad, flattened polar areas. *Aphanoascus* species have irregular reticulations over the entire ascospore. The genera are similar with respect to the construction of the peridium and the nature of the anamorph.

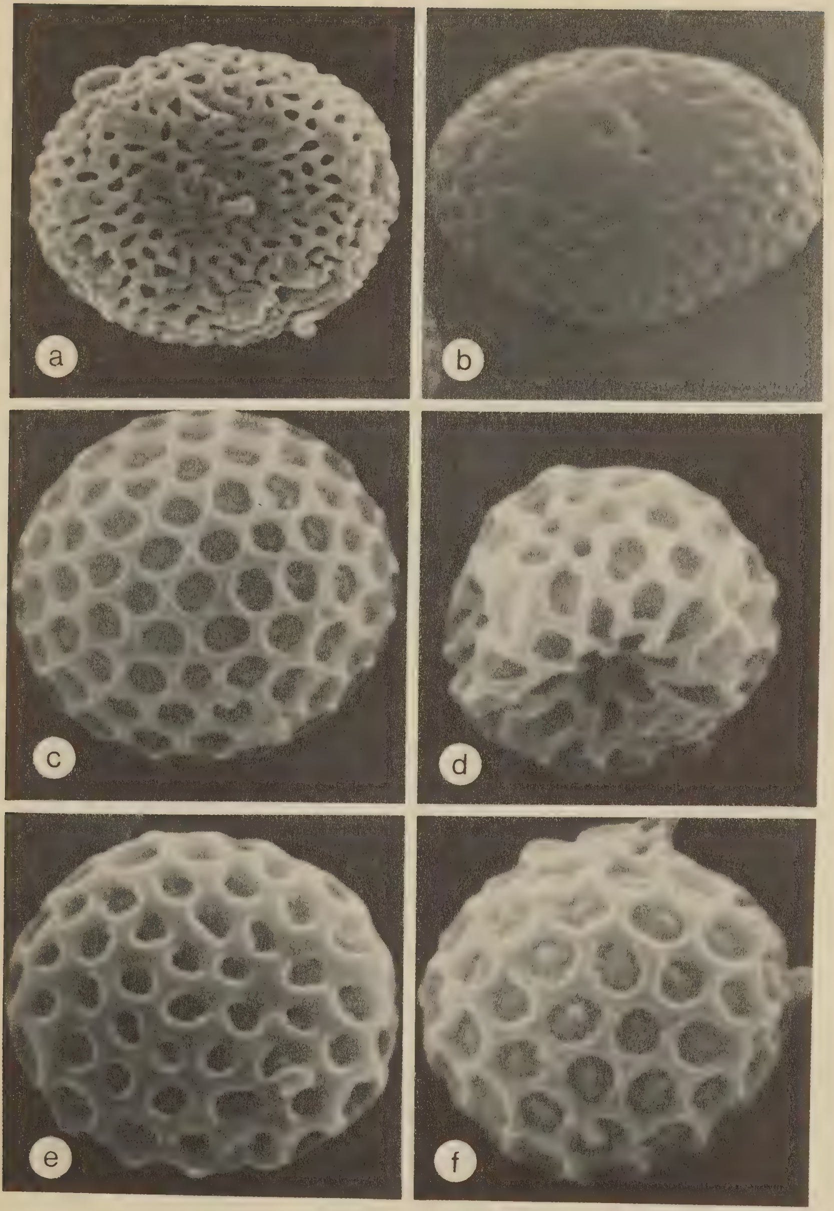
Keratinophyton durum (Zukal) Currah comb. nov.
Fig 57a,b 65d

Type material: PROPOSED NEOTYPE (*cultura desiccata*) **UAMH** 856 (chicken yard soil, Alberta).

≡*Gymnoascus durus* Zukal, Ber. dtsch. bot. Ges. 8:8 295, 1890 Taf XVII FIG 1-4, 9.

Ascomata: light grayish brown, globose, subglobose, 100-1500*u*m diam. **Ascospores:** yellowish brown, thick-walled, oblate with wide, slightly roughened, equatorial crest, (1.7-)2.5 x 3-4.5*u*m; with SEM, crest is minutely and regularly punctate, lateral faces smooth. **Asci:** 6.2-7.5*u*m diam. **Peridial hyphae:** yellowish brown, smooth, thick-walled cells, multilayered forming a membranous wall. **Anamorph:** hyaline, smooth-walled, solitary, clavate, sessile aleurioconidia, 0-1-septate, 2-3 x 4-11*u*m. **In culture:** [UAMH 856 =type strain] CER 21/25°C white, somewhat radiately fibrillose, thin; reverse pale yellow; DSA 42/25°C white, scant mycelium, scattered; reverse uncolored. PYE 28/25°C cream to tan, dense, thick, felty; reverse pale brown.

Fig. 55. a. *Xynophila mephitalis* (TRTC 42886). Oblate ascospore with numerous, deep, irregular pits. X10800. b. *Pectinotrichum llanense* (UAMH 3400). Oblate ascospore with regular puncta on margin; polar area nearly smooth. X15840. c. *Auxarthron pseudauxarthron* (UAMH 3404). Spherical ascospore with numerous, regular, circular pits. X18000. d. *Auxarthron compactum* (UAMH 3153). Oblate ascospore with large, irregular, rounded pits. X20160. e. *Auxarthron conjugatum* (UAMH 3156). Oblate ascospore in polar view. Pit rims thick; puncta ±round to slightly polygonal. X18000. f. *Auxarthron reticulatum* (UAMH 1659). Spherical ascospore with regular, rounded pits. X20160.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Notes: It is interesting that Zukal's original description contains an extremely accurate rendition of ascospore shape (Taf XVII FIG 9), which agrees in all respects with SEM results obtained here.

Material examined: UAMH 856/chicken yard soil/Alberta, coll. Carmichael; 3671/hedgehog/Ivory Coast.

Keratinophyton terreum Randhawa and Sandhu, 1964 Sabouraudia 3:253 FIG 1-7.
Figs 58a,b
Type material: HOLOTYPE **V.P. Chest Institute, University of Delhi** Kr951/3 (fowl pen soil, India).
≡*Aphanoascus terreus* (Randhawa and Sandhu) Apinis, Mycopathol. et Mycol. Appl. 35:99, 1968.

Ascomata: pale tan to dark brown, globose, subglobose or ovoid, 280-670um. **Ascospores:** light yellowish brown, smooth, thick-walled, oblate with irregular equatorial rim, 1.7-3.3 x 3.3-5um. **Asci:** globose to ovoid, 4.2-6.7 x 6.7-8.4um, 8-spored. **Peridial hyphae:** brownish yellow, smooth, thin-walled cells, 2.7-7.4 x 5.5-12um composing a multilayered, membranous wall, 18-55um thick. **Anamorph:** aleurioconidia unicellular, hyaline, clavate, slightly roughened, solitary on vegetative hyphae, 1.7-4.2 x 3.3-12um. Arthroconidia and chlamydospores also formed but not frequent. No macroconidia were observed in any of the material examined. **In culture:** [UAMH 2409] CER 14/25°C white, granular, flat; reverse slightly yellow. DSA 42/25°C scant white mycelium around hair, scattered knots of white hyphae with a few brown ascomata in vicinity of hair; reverse uncolored. PYE 14/25°C pale cream, felty; reverse pale yellowish brown.

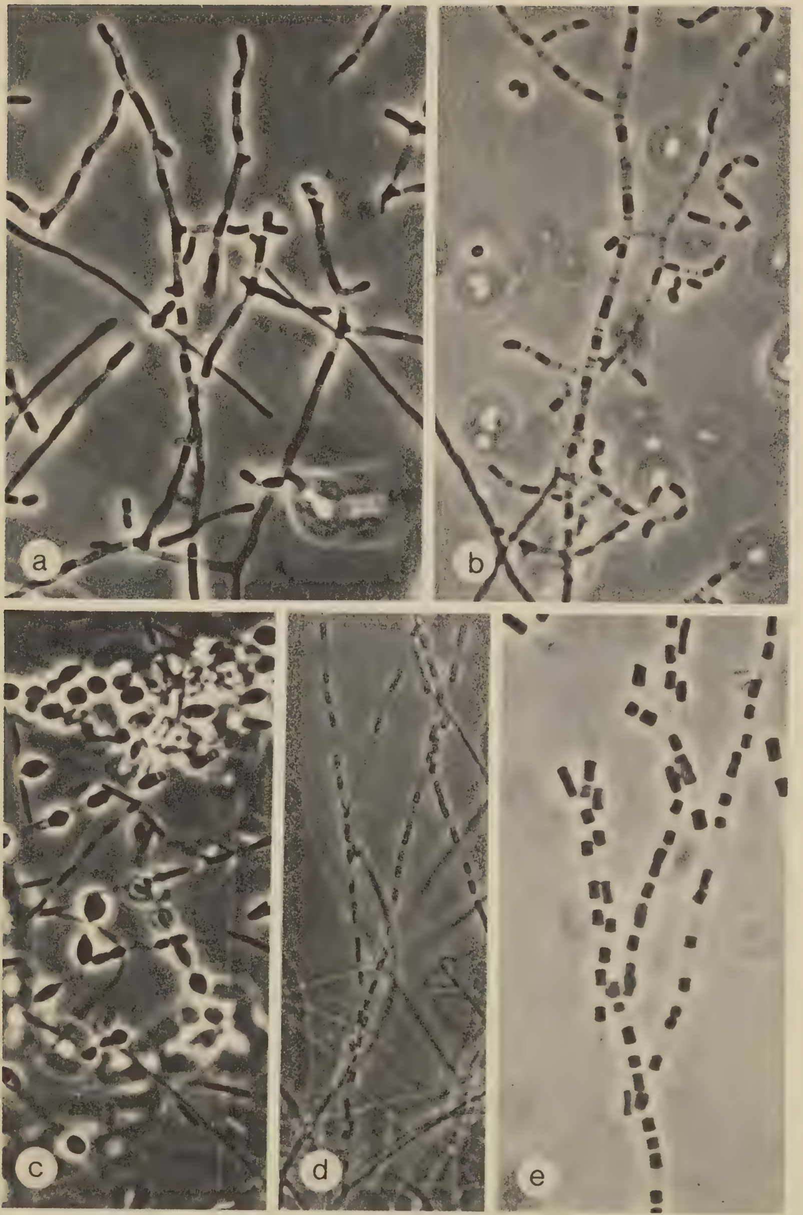
Notes: This species is distinguished from *Keratinophyton durus* by having an asymmetrical equatorial band. The anamorph of this species was named *Chrysosporium indicum* (Randhawa and Sandhu) Garg (1966).

Material examined: UAMH 2409/hair-baited soil/Kenya; 2561/domestic fowl/Australia; 2748/soil/Mozambique; 4616/soil/Spain.

KUEHNIELLA Orr, 1976
Mycotaxon 4:171.

Type species: *Kuehniella racovitzae* (Lagarde) Orr.

Fig. 56. (Phase contrast microphotographs). a. *Auxarthron californiense* (UAMH, 1889). Anamorph of alternate, intercalary and terminal conidia. X600. b. *Auxarthron conjugatum* (UAMH 3156). Anamorph of broad, intercalary conidia on main hypha; side branches sinuate, with smaller intercalary conidia. X600. c. *Auxarthron zuffianum* (UAMH 4484). Swollen, alternate, intercalary arthroconidia. X600. d. *Auxarthron umbrinum* (UAMH, 1875). Slender intercalary conidia in long chains. X600. e. *Auxarthron reticulatum* (UAMH 1585). Broad, barrel-shaped or squarrose, alternate, arthroconidia in chains. X600.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Ascomata: white, globose. **Ascospores:** hyaline, globose, walls irregularly ridged and punctate. **Asci:** spherical, 8-spored. **Appendages:** helical hyphae. **Peridial hyphae:** similar to vegetative hyphae. **Anamorph:** arthro and aleurioconidia.

Notes: Von Arx (1977) placed the genus in synonymy with *Arachnotheca* [*Kuehniella racovitzae* (Lagarde) Orr =*Arachniotus albicans* ≡*Arachnotheca albicans* (Apinis) Von Arx (1977)] but this is inappropriate since ascospores of the types are very different. Not only does *Arachnotheca* have sheathed spores, it also has fission arthroconidia. "*Arachniotus albicans*" which is a species of *Amauroascus* q.v., also distinctly different because of its ascospores.

Kuehniella racovitzae (Lagarde) Orr, 1976 Mycotaxon 4:171-178.

Fig. 69c

Type material: NEOTYPE (*cultura desiccata*) **NY** O-3436 (dog lesion, Kansas) *fide* Orr, 1976.

≡*Myxotrichum racovitzae* Lagarde, Arch. Zool. Exper. Gener. 53:280, 1913.

≡*Gymnoascus racovitzae* (Lagarde) Lagarde, Arch. Zool. Exper. Gener. 53:281, 1913.

Ascomata: white, ±spherical, 50-1400*u*m diam. excluding appendages, confluent. **Ascospores:** hyaline, globose, 2.3-4.2*u*m diam., thick-walled, finely and irregularly punctate-reticulate. **Asci:** spherical, 5.7-11.4*u*m diam., 8-spored. **Peridial hyphae:** loose arrangement of apparently undifferentiated vegetative hyphae, forming a telaperidium. **Appendages:** helical appendages forming at periphery of ascoma, variable in length and number of turns. **Anamorph:** hyaline, aleurioconidia pyriform, 2.2-4.2 x 5.6-6.7*u*m; arthroconidia ±cylindrical, 1.9-2.9 x 4.2-9.5*u*m. **In culture:** [UAMH 3767]. CER 42/25°C white, felt-like, uniform; reverse brown. DSA 42/25°C white to pale brownish yellow, sectored mycelium, sparse but extensive; reverse concolorous with rosy brown areas. PYE 14/25°C cream, buff or pale tan, slightly cottony with numerous white knots, submerged in vegetative hyphae; reverse yellowish brown.

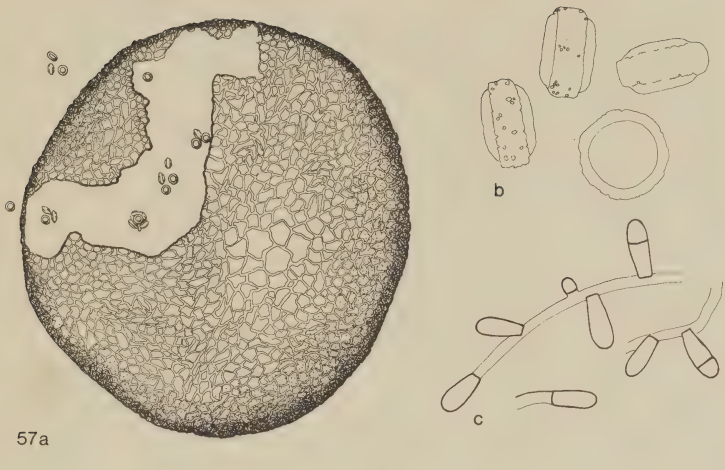
Notes: Holotype was obtained from rotting wood found in a cave in France. Other isolations are recorded from "organic matter", insect remains, dog lesion, sputum, mouse dung and soil. I found this species once on carnivore dung which had been collected in southern Alberta.

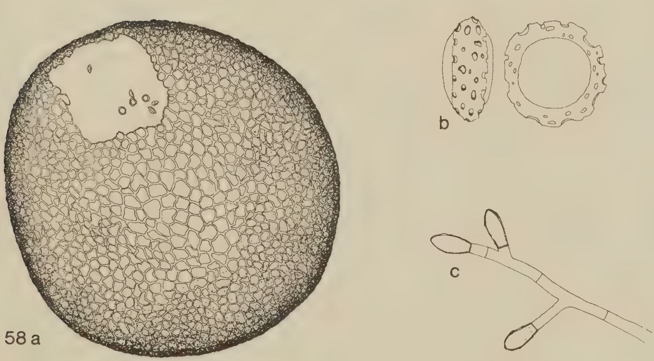
Material examined: FH, NY (type as cited); O-3212/sputum/Kansas; O-1294/mouse dung/Colorado; *UAMH* 3767 (type strain as cited), from Orr.

NANNIZZIOPSIS Currah, gen. nov.

Typus: Nannizziopsis vriesii (Apinis) Currah, comb. nov.

Ascoma alba dein griseo-lutea, globosa, <1mm diam. Ascosporae hyalinae, minutae, globosae cum foveis multiangulis, <3.5um. Asci globosi vel subglobosi, octospori, <8um diam. Hyphae peridii hyalinae, asperulatae, septae constrictae, ramosae et anastomosae. Appendicula hyalina, simplex, aut quod discerni non potest. Stat. conid.





Figs 57-58. 57. *Keratinophyton durum* (UAMH 856). a. Cleistothecial ascoma with membranous wall. X410. b. Thick-walled, oblate ascospores with symmetrical, wide, punctate equatorial crest. X2645. c. Anamorph of smooth-walled, clavate, sessile conidia. X725. 58. *Keratinophyton terreum* (UAMH 2409). a. ±Globose cleistothecial ascoma. X250. b. Ascospores with an asymmetric, broad, irregularly punctate, equatorial rim. X3645. c. Clavate, slightly roughened, solitary aleurioconidia. X550.

aleuriosporae et arthrosporae.

Ascomata: white, becoming grayish yellow, globose, <1mm diam. **Ascospores:** hyaline, small, globose with polygonal pits. **Asci:** globose to subglobose, 8-spored, <8um diam. **Peridial hyphae:** hyaline, constricted at septa, branched and anastomosed, asperulate. **Appendages:** hyaline, simple or indistinguishable from peridial hyphae. **Anamorph:** aleurioconidia and arthroconidia.

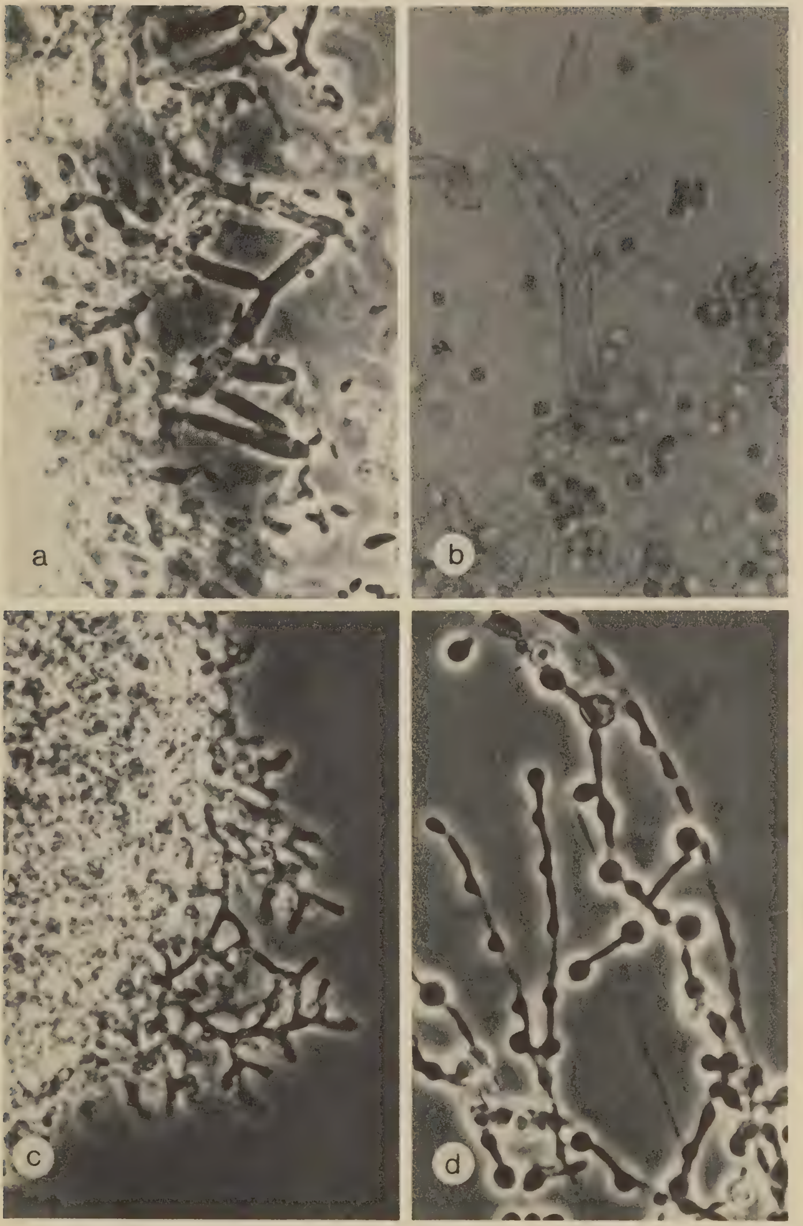
Notes: Apinis' concept of the genus *Rollandina* accommodated *Rollandina vriesii* primarily on the basis of the nature of the hyphae found on the stalk of Patouillard's collection named *Rollandina capitata*. This collection consists of at least two separate fungi and I have followed Von Arx (1971) in rejecting the genus name on the grounds that it is a *nomen confusum*. The keratinolytic capacity and punctate ascospore walls place *Rollandina vriesii* in the Onygenaceae. Since it does not closely resemble any of the other genera in that family, it is described here as a new genus.

The asperulate peridial hyphae with septal constrictions closely resemble the peridial hyphae found in *Arachnotheca*. *Arachnotheca* however has sheathed ascospores and a distinctive anamorph of fission arthroconidia.

Peridial hyphae, typical of *Nannizziopsis*, occur also in collections labelled *Onygena bommerae* (BR) and "*Ctenomyces*" (FI). Both collections lack ascospores corresponding to *Rollandina vriesii* although the material at FI has typical *Gymnascella aurantiaca* ascospores in some parts of the material.

Because of the presence of similar peridial hyphae and puncta on the ascospores, I suggest that *Apinisia queenslandica* should probably be transferred to *Nannizziopsis*. It appears to be more closely related to *Nannizziopsis vriesii* than to *Apinisia graminicola* which, from the original description, most closely resembles *Shanorella*. Apinis and Rees (Trans. Brit. mycol. Soc. 67:524, 1976 FIG 1A-J) described *Apinisia queenslandica* (based on HOLOTYPE CMI 121675, from feathers, Australia) as follows: **Ascocarps:** brown at maturity, globose, soft(?), solitary or gregarious, 350-1000(-1540)um diam. **Ascospores:** globose, ellipsoidal (lens-shaped), yellow becoming brown, thick, finely verrucose wall, 3.5-5(5.3)um diam. **Asci:**

Fig. 59. (a,c and d are phase contrast microphotographs). a. *Nannizziopsis vriesii* (UAMH 3598). Asperulate peridial elements at periphery of ascoma. Hyphae constricted at septa. X600. b. *Nannizziopsis vriesii* (FH Trinidad). Characteristic hyphal branching pattern of peridial hyphae and globose, minutely roughened ascospores. X865. c. *Neogymnomyces demonbreunii* (UAMH 3382). Dichotomously branched peridial hyphae. X600. d. *Neogymnomyces demonbreunii* (UAMH 3382). Intercalary and terminal conidia often swelling on one side. X600.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globose to ovoid, 7-12 x 9.5-13(15)*u*m, 8-spored. **Peridial hyphae:** hyaline, finely verrucose, anastomosed, septate, 4-6*u*m thick, somewhat constricted at septa. **Appendages:** brown, smooth, septate, irregularly helical, 1.5-4*u*m. **Anamorph:** *Chrysosporium queenslandicum* Apinis and Rees; aleurioconidia hyaline, aseptate, single or in short chains, smooth, pyriform, 2.5-3.5(4.1)*u*m. The type strain (UAMH 4319) has not ascosporulated and formal disposition of the species requires information not provided by the original description or by the strain available.

Arachniotus hebridensis according to Apinis (1964) also appears to be closely related to *Nannizziopsis*. I have not examined the holotype but the type strain received by UAMH is a strain of *Geomyces pannorus* (Hyphomycetes). It is possible that this was a contaminant in the original isolate. Udagawa and Takada (1968 and 1973) applied the name *Arachniotus hebridensis* to isolates from pig dung and soil, Japan. This taxon is keratinolytic but has not fruited at UAMH. Further work with these collections is needed before they can be disposed with confidence.

Nannizziopsis vriesii (Apinis) Currah, comb. nov.
Figs 59a 60a,b,c
Type material: HOLOTYPE (*cultura desiccata*) **CMI** 149994 ("Amieva" skin, Holland?).
≡*Rollandina vriesii* Apinis, Trans. Brit. mycol. Soc. **55:** 499-502, 1970 FIG 1A-Z (Basionym).
≡*Arachnotheca vriesii* (Apinis) Samson *apud* Von Arx, 1981a

Ascomata: white, becoming grey to yellowish, globose, solitary or gregarious, 300-1000*u*m diam. **Ascospores:** hyaline, appearing spiny to reticulate with light microscope, globose, 2-3*u*m diam. **Asci:** ±globose, 6-8*u*m diam., 8-spored. **Peridial hyphae:** hyaline, branched and anastomosed, constricted at septa, asperulate, 2.5-5*u*m diam. **Appendages:** a few long, smooth, hyaline hyphae. **Anamorph:** hyaline, smooth arthroconidia, and pyriform to clavate aleurioconidia, 2-3 x 3-8*u*m. **In culture:** [UAMH 3527]. CER 21/25°C white, heaped in localized patches; reverse very pale yellowish cream. DSA 42/25°C white, scant, reverse white. PYE 21/25°C white, dense, cracking (or with small fissures) when dried; reverse white except at margin where yellow-orange band is formed.

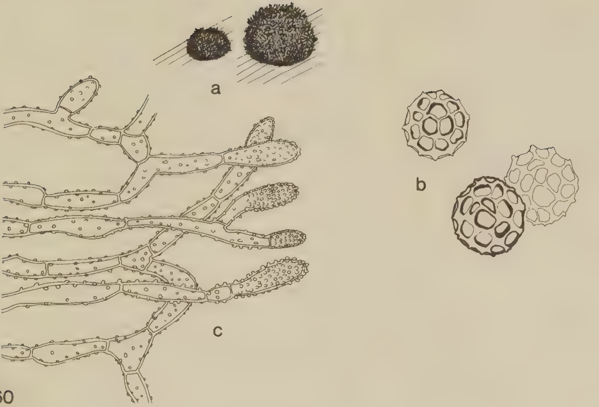
Notes: Known only from type collection and one collection at FH.

Material examined: UAMH 3527 from CBS, (=UAMH 3598 from CMI) (type strain as cited); **FH** "roach wing," Trinidad.

NEOGYMNOMYCES Orr, 1970
Can. J. Bot. **48:**1061.

Type species: *Neogymnomyces demonbreunii* (Ajello and Cheng) Orr

Ascomata: yellowish, ±spherical. **Ascospores:** pale yellow, irregularly grooved, ovoid, <4.5*u*m maximum. **Asci:** hyaline, globose or obovoid, 8-spored. **Peridial hyphae:** hyaline, smooth, thick-walled, sinuous, free ends form simple or branched appendages. **Appendages:** hyaline, simple, or



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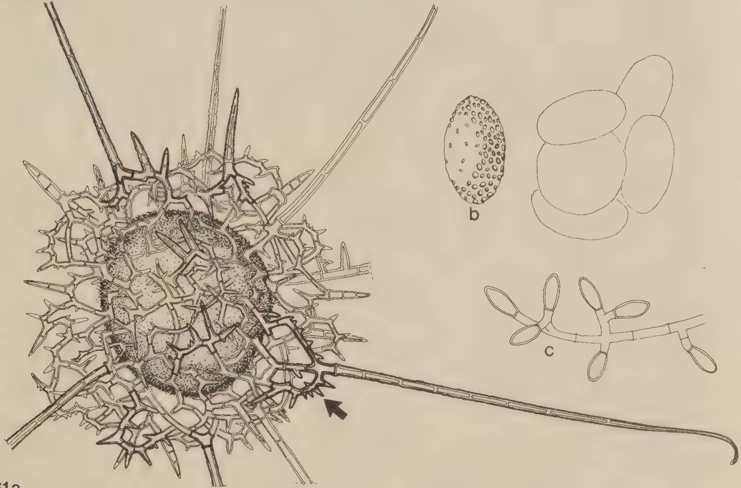


61a

Figs 60-61. 60. *Nannizziopsis vriesii* (UAMH 3527). a. Habit view of two ascomata on roach wing (This drawn from FH, "roach wing," Trinidad). X2.3 approx. b. Ascospores with punctate-reticulate walls. X4700. c. Branched, anastomosed, asperulate hyphae of peridium; hyphae with characteristic constrictions at septa. X750. 61. *Pectinotrichum llanense* (NY 0-779). a. Elaborately appendaged reticuloperidium showing elongate, tapering appendages and pectinate structures (arrow). X255. b. Oblate, thick-walled, punctate ascospores. X4700. c. Anamorph of smooth, bluntly pointed aleurioconidia. X940.

unequally bifurcate, sinuous, smooth, septate, apices rounded or swollen. **Sexuality:** homothallic. **Anamorph:** aleurioconidia and arthroconidia. **Degrades:** keratin.

Notes: Von Arx (1974) placed this genus in synonymy with *Gymnoascus* even though Orr's account of *Neogymnomyces* was carefully defended (1970). The light microscope reveals that the ascospores are definitely sculptured but this feature has never been reported. Sculptured ascospores, the rhexolytically dehiscing conidia, and the ability to degrade keratin, adequately distinguish *Neogymnomyces* from *Gymnoascus*, and confirm its placement in the Onygenaceae.

Neogymnomyces demonbreunii (Ajello and Cheng) Orr, 1970 Can. J. Bot. **48**:1061 FIG 1-8.

Figs 51b 59c,d

Type material: NEOTYPE (*cultura desiccata*) **NY** ATCC 18394 (soil, Missouri).

≡*Gymnoascus demonbreunii* Ajello and Cheng, Mycologia 59:692, 1967 (Basionym).

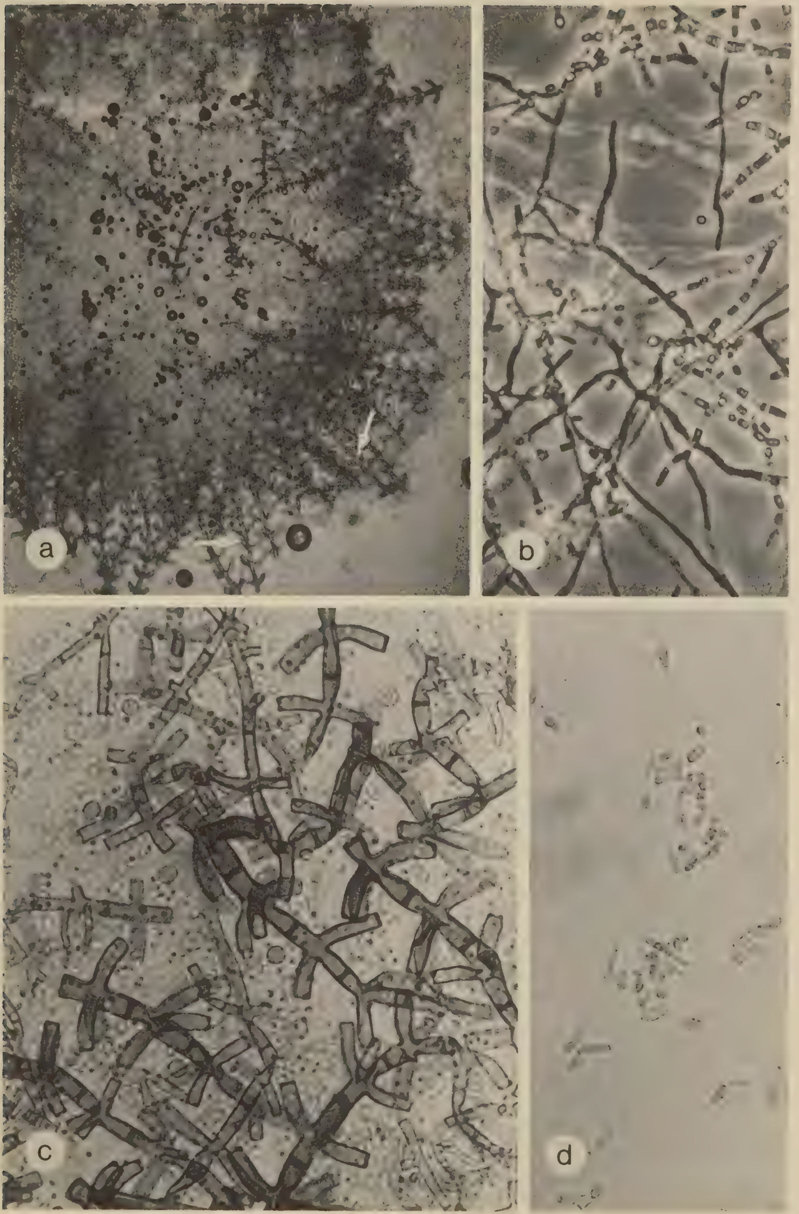
Ascomata: yellowish or golden, discrete, ±spherical, 73-400μm diam., naked asci also present in culture. **Ascospores:** yellowish, spherical, discoid-oblate, punctate to almost smooth, 2.5-3 x 2.5-4.4μm. **Asci:** hyaline, obovoid, 5.3-6.5 x 8.6-8.8μm. **Peridial hyphae:** hyaline, smooth, thick-walled, septate, sinuous, anastomosed. **Appendages:** hyaline, 25-260μm long, apices simple, blunt or with short dichotomous branches. **Anamorph:** arthroconidia and aleurioconidia, variable in size and shape, to 14.2μm long. **In culture:** [UAMH 3382]. CER 35/25°C yellow tan, granular with concentric white zones, radiately sulcate; reverse brownish yellow. DSA 42/25°C white, granular, pale brown; reverse yellow. PYE 28/25°C faintly concentrically zonate (pale yellow with pale tan); reverse yellow to pale orange-brown.

Notes: Orr's ascospore measurements are rather small. Ajello and Cheng (1967) originally described *Gymnoascus demonbreunii* as the sexual state of *Histoplasma capsulatum* Darling. This was refuted by Kwon-Chung (1968) and Orr (1970). The species is known from two isolations: human, Puerto Rico; and soil, Missouri.

Material examined: UAMH 3382 (type strain as cited).

NEOXENOPHILA Apinis and Clark, 1974
Trans. Brit. mycol. Soc. **63**:263.

Fig. 62. a. *Oncocladium flavum* (UAMH 4804). Ascoma-like assemblage of *Oncocladium flavum* (arrows) and its synanamorph *Malbranchea flava*. X80. b. *Malbranchea flava* (UAMH 4806). Intercalary and terminal conidia. X555.(Phase contrast microphotographs). c. *Oncocladium flavum* (UAMH uncatalogued). Thick-walled *Oncocladium flavum* appendages with verticils of reflexed appendages. X490. d. *Onygena equina* (DAOM 124593). Irregular arthroconidia of *Sporendonema* state. X425.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Type species: *Neoxenophila foetida* Apinis and Clark.

Ascomata: globose to subglobose, tomentose, nonostiolate, ±aggregated superficial. **Ascospores:** globose to ovoid (oblate?), <5*u*m maximum. **Asci:** globose to ovoid. **Appendages:** lacking. **Peridial hyphae:** form 3 distinct layers: 1. an outer layer of loose vesicular hyphae with hyaline appendages; 2. a brown membranous layer of flattened cells; and, 3. an inner layer of hyaline pseudoparenchymatic cells. **Anamorph:** *Chrysosporium*, conidia 0-1 septate.

Notes: As the name implies, there is a striking resemblance between this genus and *Xynophila* q.v. Examination of the holotype may prove that there are no grounds for maintaining this genus as a distinct taxon.

Neoxenophila foetida Apinis and Clark, 1974 Trans. Brit. mycol. Soc. **63**:263-264.

Type material: HOLOTYPE (*cultura desiccata*) **CMI** 156967 (rat, Nigeria).

Anamorph name: *Chrysosporium foetida* Apinis and Clark.

Ascomata: brownish, 200-400*u*m diam., hairy, globose to subglobose, ±aggregated, superficial. **Ascospores:** hyaline to brown, globose to ovoid, 1.5-2.7 x 3.5-4.8*u*m, apparently smooth. **Asci:** subglobose to ovoid, evanescent, 5.5-6.5 x 7-10-15*u*m. **Peridial hyphae:** 3-layered: outer layer of loose vesicular hyphae; middle layer of brown membranous cells; inner layer of hyaline membranous hyphae. **Anamorph:** Microconidia hyaline, smooth, 1-celled, 2-3.5 x 3-8(10)*u*m. Macroconidia hyaline, smooth, clavate, 2.5-5 x 10-25(-30)*u*m "similar to *Trichophyton*." Chlamydospores hyaline apical or intercalary, globose to ovoid or clavate. **In culture:** no data.

Notes: Tentative placement until holotype examined.

Material examined: none; description from original.

ONYGENA Persoon 1795
Observationes Mycologicae **2**:71.

Type species: *Onygena equina* (Wildenow) Persoon.

Ascomata: borne in a white to brown, fissured or rugulose, globose ascostroma borne on the apex of a cylindrical or somewhat flattened stipe, 500-1000*u*m diam. and up to 1.5cm long. **Ascospores:** hyaline to tan, ellipsoidal to slightly reniform or allantoid, broadly rounded at both ends, minutely pitted. **Asci:** arising from croziers among tissue of stroma of the capitulum, to 14*u*m. **Appendages:** lacking. **Peridial hyphae:** stroma composed of hyaline, polygonal and

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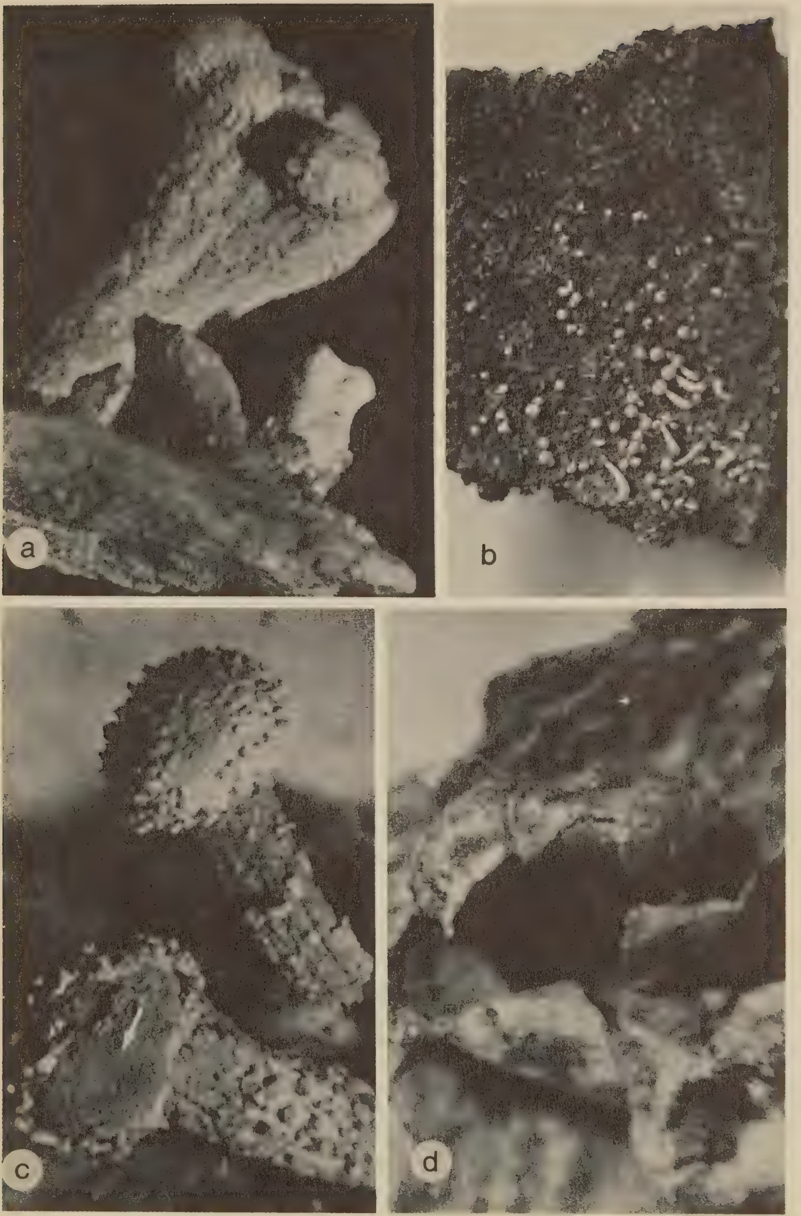
Fig. 63. a. *Onygena equina* (FH Thaxter 1026). Atypical fruit body with a large, irregularly lobed head. X5. b. *Onygena equina* (BR Roumeguere 307). Fruit bodies on woollen fabric. X1.5 c. *Onygena equina* (FH Thaxter 1026). Rugulose outer covering ruptured to expose ascospores in head. X6. d. *Onygena caprina* (PAV 246). Ruptured fruit body. X22.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filamentous cells. **Sexuality:** unknown. **Anamorph:** *Sporendonema*.

Notes: Gaumann (1928) briefly mentioned the formation of multiple ascogenous coils within the capitulum of *Onygena*. This has been observed also by Malloch (1981). For this reason, and after examining squashes of numerous dried specimens, I feel that the head of *Onygena* (long regarded as an individual ascocarp) represents a stroma which encloses a number of individual ascomata. Unfortunately there are no published developmental studies to confirm this.

There are two species in the genus: *Onygena corvina* and *Onygena equina*. A third recognizable taxon which has been placed in the genus is *Onygena caprina* Fuckel (see Figs 63d, 64a,b,c). (**Ascomata:** buff to tan brown, clustered, spherical or irregular, 1.2-3.5mm diam. **Ascospores:** reddish brown, limoniform, 4.5-5.5 x 6-9*u*m. **Asci:** spherical, 13-15*u*m, oblate with scalloped equatorial frill in polar view, 3.9-4.7 x 8-8.6*u*m. **Peridial hyphae:** tightly woven hyphae. **Appendages:** lacking. **Anamorph:** unknown. **In culture:** none known). I have examined four collections of this species (**TRTC** Demetrio 2687/cow horn/Missouri; **NY** Demetrio 268/cow horn/Missouri; **PAV** 246/horn/?; **G** Barb. Bois./horn/?), and feel that it requires reallocation. The ascospores are not punctate, but resemble large *Gymnascella marginospora* ascospores. It has only been found on keratinous materials in nature. There is no information on the anamorph and the organism does not exist in culture. Reallocation should await the availability of fresh isolations.

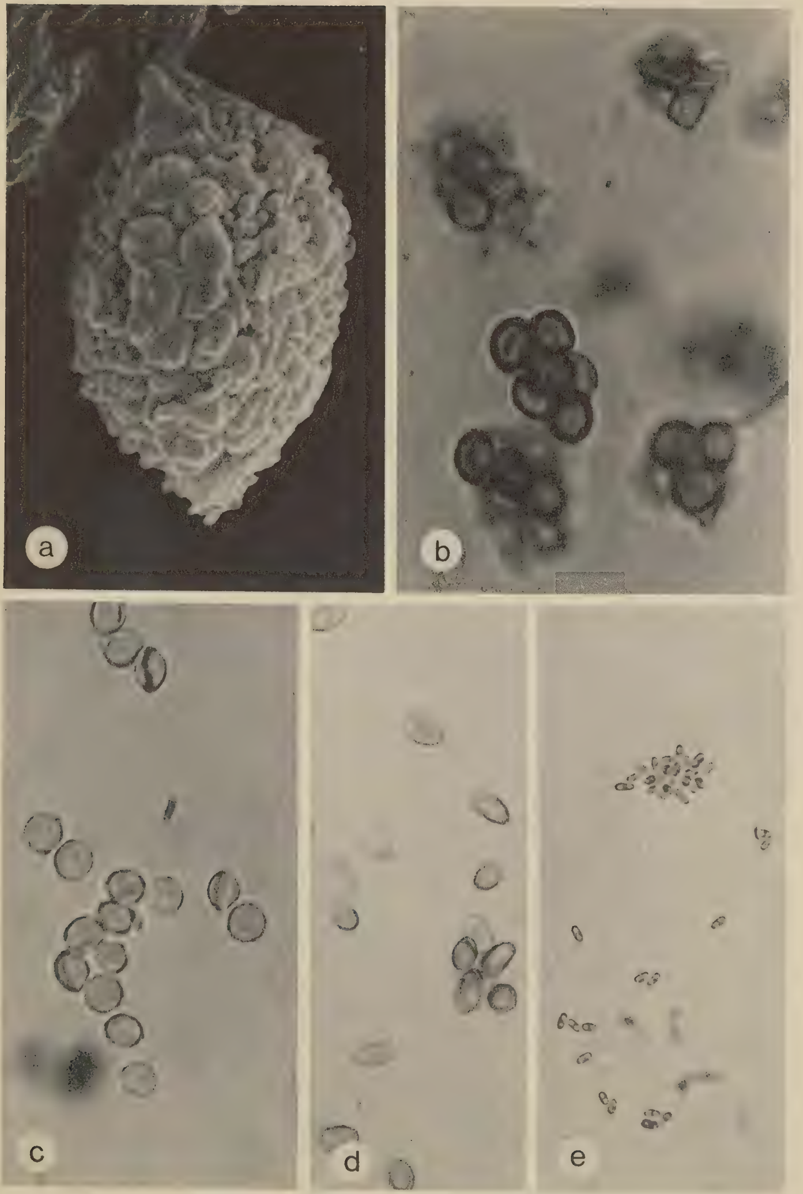
The unique macroscopic nature of *Onygena corvina* and *O. equina* has invited attention from many mycologists. They are usually considered macrofungi, and consequently receive attention from those who compile regional floras (see Breitenbach and Kranzlin, 1981 -plates 374 and 375).

I have observed either type or authentic material for the following species, formerly disposed in *Onygena*. Some suggestions as to the identity of these taxa are provided.

Onygena alpina (Fres.) Rytz, Mitteil. Natur. Ges. Bern. Sitzber page 2, 1923
?=*Phleogena faginea* (Fries) Link., see Carmichael *et al.* 1980.
?≡*Onygena faginea* Fries.

Onygena apus Berkeley and Broome, Ann. Nat. Hist. no. 582 see Saccardo, Sylloge Fungorum 8:862, 1889.
(Collections I have examined under this name have been

Fig. 64. a. *Onygena caprina* (BR Roumeguere 307). Irregularly knobbed, ±oblate ascospore with thick, irregular equatorial band. X9000. b. *Onygena caprina* (BR Roumeguere 307). Ascal cluster. X1165. c. *Onygena caprina* (BR Roumeguere 307). Individual ascospores with irregular, equatorial bands. X935. d. *Onygena equina* (MICH -Smith-). Broad, allantoid, apparently smooth ascospore. X8500. e. *Onygena corvina* (BR -Belgium 604-). Slender, allantoid, ascospores, each having two prominent guttules. X330.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similar to *O. caprina*).

Onygena bommerae Rousseau and Saccardo, Ann. Myc. 11:322, 1913
(Species uncertain *fide* Rammeloo - based on one presently sterile collection on feathers of a dead bird; hyphae very similar to *Nannizziopsis vriesii*).

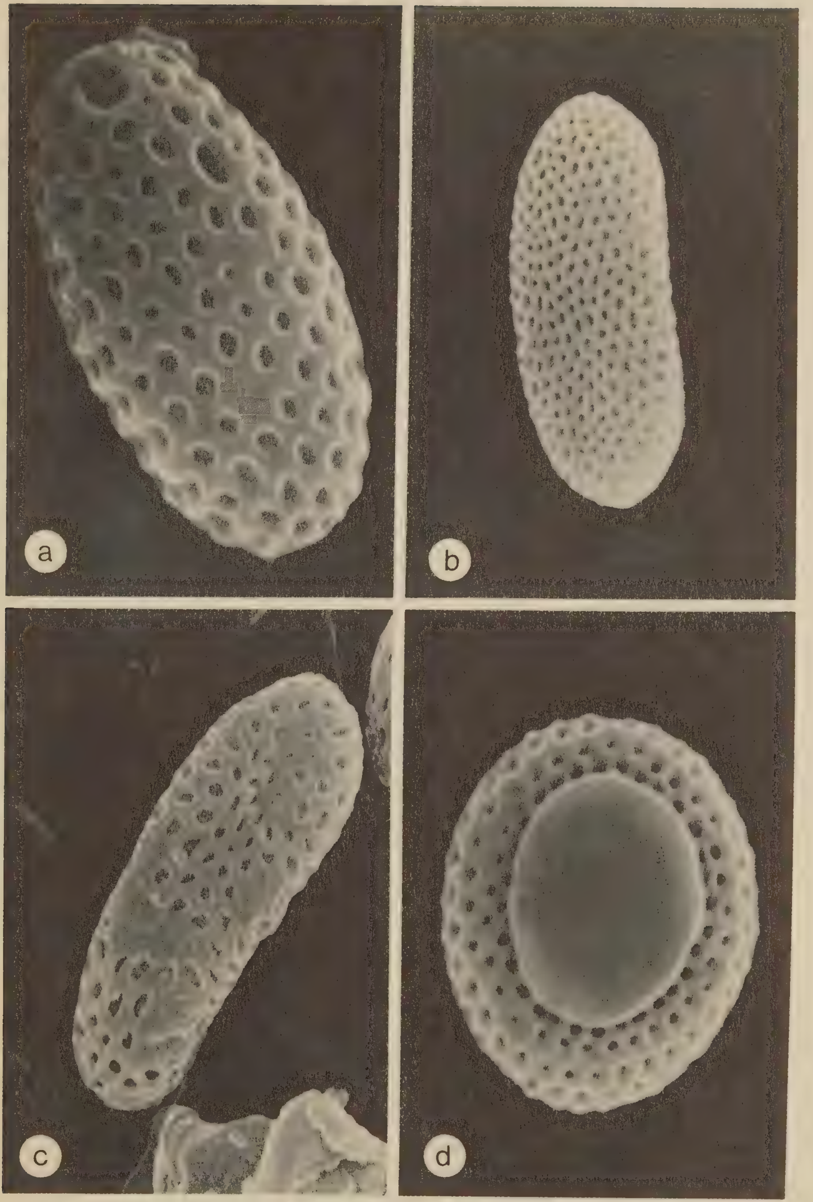
Onygena mutata Quelet, Champ. Jura et Vosges 3:449 t.1, f. 6, 1886. (Saccardo, Saccardo, Sylloge Fungorum 8:862, 1889.)
≡*Amauroascus mutatus*.

Onygena corvina Albertini and Schweinitz, 1805 Consp. Fung. p 113, t 9, f 2.
Figs 64e 65b
=*Onygena hysipus* Ditmar in Sturm. Deutschl. Fl. III:15 t 12, 1817 *fide* Fries, 1832.
=*Onygena piligena* Fries, Systema Mycologicum 3:208, 1832 *fide* Pilat, 1956.
=*Onygena murina* Sommerfelt, Suppl. Fl. Lapp. pg 247, 1826 *fide* Fries, 1832.
=*Onygena corvina* var. *alliacea* Bommer and Rousseau, Mem. Roy. Soc. Bot. Belgium 25:193 see Rammeloo, 1977.

Ascomata: in cream or brown or ochre capitulum, 0.9-2mm wide, on apex of solid synnema-like stalk (13mm long and up to 1mm in diam.). **Ascospores:** hyaline to pale yellow-brown, appearing smooth, ovoid or ellipsoidal-cylindric, slightly curved, 2-4 x 5-8*u*m. **Asci:** ellipsoidal to globose, 7-9 x 9-14*u*m. **Peridial hyphae:** wall of capitulum white to ochre, smooth, granular or warted; two-layered: outer layer membranous, of large, inflated cells; inner layer filamentous. **Anamorph:** arthroconidia numerous, hyaline, alternate, cylindrical, straight or slightly curved, having a frill at both ends, 3.5-6.5 x 9.5-18*u*m; chlamydospores abundant, variable, 6-10*u*m diam. some conidia terminal, clavate, 4-6 x 10-18*u*m. **In culture:** [UAMH 3852]. CER 14/25°C yellowish white, irregular growth forming a pinwheel pattern; reverse concolorous. DSA 42/25°C growth very scant, white; reverse pale yellow under inoculum. PYE 14/25°C white, cottony, margin radiately ridged; reverse yellow to orange-brown.

Notes: Tubaki (1960) studied the species in culture and referred to the anamorph as "*Coremiella*-like. Samson and Van der Aa (1973) provide a careful developmental study. They report that the size of the fruit body is extremely variable depending on "external circumstances." Fructifications that grow from darkness to the light often have longer stalks than those formed under full daylight. 'Heads' may vary from 1.5-3mm in diam. The stalk may be 13mm tall. This fungus is not infrequent in the Netherlands, where it is found on feathers, bird nests, bird skulls and wool.

Material examined: NY Massee/Feathers/?/ (Drawing); **BR** Rammeloo 5198/?/Nazareth (undetermined natural material); Beeli 604/dead crow/Belgium (remains of bird); **DAOM** 48905/feather/British Columbia (feathers); **MICH** Smith/mouse remains/Michigan (mouse remains); **FH** Thaxter 7320/owl casting/New Hampshire (culture); **UAMH** 3852/wool/culture obtained from CBS.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Onygena equina (Wildenow) Persoon Obs. Mycol. 2:71.
Figs 62d 63a,b,c 64d 65c
Type material: Possibly no type specimen.
≡*Lycoperdon equinum* Wildenow, Fl. Ber. Podr. p 412, t. 7, f. 20, 1787. (Sowerby, Coll. Engl. Fgi. t. 292, 1803.)
=*Onygena caespitosa* Persoon, J. Bot. 2:20, 1809 Plate XV figs 27-35.

Ascomata: on apex of cylindrical or flattened stalk, white to cream, yellow or buff, smooth, warted or scaly, up to 1.3cm long and 0.6-1.2mm thick; capitulum white, yellow or brown, smooth, warted or scaly, spherical or globoid or extremely irregular, up to 8mm diam., gregarious or scattered. **Ascospores:** buff to tan, ochre-brown in mass, ellipsoidal, slightly tapered on one end, minutely punctate, 3-5.5 x 5-9*u*m. **Asci:** subglobose to globose, 10-14 x 14-22*u*m in diam., nonstipitate, arising from croziers and irregularly disposed throughout vegetative hyphae within the capitulum. **Peridial hyphae:** wall of capitulum two-layered: outer layer 15-120*u*m thick, membranous, of large irregular cells, 4-10.5*u*m diam.; inner layer of loosely interwoven hyphae, interwoven hyphae, 60-110*u*m thick. **Appendages:** lacking. **Anamorph:** on simple conidiophores or in synnemata; hyaline terminal aleurioconidia or arthroconidia, cylindrical or ellipsoidal, truncate, smooth 3.5-7 x 5-12*u*m. **In culture:** [UAMH 3829]. CER 21/25°C white, granular; reverse yellowish. DSA 42/25°C growth yellowish, localized in knots in centre; reverse concolorous. PYE 21/25°C rosy buff, granular, slightly cracked; reverse yellowish orange.

Notes: Strongly keratinolytic. Specimens in Herb. E contain artificially inoculated substrata including horn, hoof, hedgehog spines and human toenails. Generally larger than *Onygena corvina*. When grown on keratin from horse hoof, cultures produced sterile stipitate structures to 8mm in height with the outward appearance of being fertile stromata as found in nature.

Both species are very variable in the shape and form of the stromata.

Material examined: (In the following list "-" indicates that the material on which the specimen was found was either hoof or horn). **ANSM** Menke/-/?; Menke 39/-/Germany?; **BP** 41923/-/Hungary; **BR** ?/-/? (4 specimens); Herb. Westendorp/-/?; M434/-/?; M664/-/?; Rel. Libert./-/Malmedy; Roumeg 307/wool hat/France (3 specimens); 1074/-/?; XXXIX/-/?; **DAOM** 122143/-/Michigan; 124593/owl pellet/N.W.T;

<---Fig. 65. a. *Renispora flavissima* (UAMH 4205). Thick-walled, regularly punctate ascospore. Pit rims smooth, round and regular. X18000. b. *Onygena corvina* (BR Belgium 604). Thick-walled, allantoid, regularly punctate ascospores. Puncta rounded to irregular. X8280. c. *Onygena equina* (MICH Smith). Thick-walled, irregularly punctate ascospore. Puncta rounded to irregular. X9000. d. *Keratinophyton durum* (UAMH 3671). Thick-walled, oblate ascospore with thick, broad, regularly punctate equatorial band. Polar region rounded and smooth. X14400.

124667, 124668/muskox horn/N.W.T; 132754/-/Quebec; 133958/muskox pellets/N.W.T.; 150873/-/Hungary; 5271, 56538, 84949, 86836, 87230, 154836/-/Quebec; 36534/-/Sweden; 37457, 37458/-/Ontario; 59086/-/?Vogeso Rhen.; 62734/-/B.C.; **DBN** Mougeot 775/-/?; Roumeg. 1677/-/France; Roumeg. 307/old hat/France (as variety "*caespitosa*"; **E**Hend. 4121, 9143/-/Britain; J.T. Palmer/assorted natural keratins/?; Moug. and Nest. 775/-/? (3 specimens); 1034/sheep carcass/Scotland; 183/-/Scotland (3 specimens); **FH** ?/-/Vermont; ?/?; ?/-/Michigan; ?/?; ?Peck/-/Floodwood; ?1326/-/?; ex Herb J. Lind/-/Denmark?; ex Herb. Kew/-/England; Herb. Bartholemew/-/? J. Faull 7116/-/Mass.; THAX? 1027, 2765/-/Conn.; THAX 1202/-/?; White 1646/?/New York; THAX? 1026/-/Conn. (giant form); Lloyd 6984/-/Canada (Patouillard); 551/S5355/-/Leveille? (Patouillard); **LE** ?/-/Petropol? (2 specimens); date, 1893/-/Uppsala; date, 1898/woolen fabric/USSR?; ex Herb. Wiatkansis/-/USSR; Herb. Weinmann/-/?; Holls Schmidt XXXIX/-/Germany; Rabenh. 2338/?/Baltra? (2 specimens); 1074/-/Morthier?; 645/-/Germany; 775/-/Vogeso-Rhen. 780/-/Sweden; 86/?/?; **MICH** Drummond/-/Michigan; Fitzpatrick/-/New York; Harrison 11868/-/Nova Scotia; Kauffman/-/New York; Smith/baseball(!)/Washington; Smith/-/Michigan; Ellis 75/-/Ontario; **NY** H.J. Banker?/-/New York (2 specimens); H. J. Banker 1326/-/New York; Karsten 178/-/Finland; Massee/?/?; Mougeot 775/-/Vogeso-Rhen; NYBG, 1821/-/England; NYBG 65-118/-/New York; Roum. 307, 4913/-/France; Sturgis/-/Colorado; 1326/-/New York; **NYS** C. H. Peck/-/New York? (2 specimens); G. W. Clinton/-/New York (2 specimens); H. J. Banker/-/New York (2 specimens); Macoun/-/Ottawa; Patouillard/-/France; C. H. Peck/-/New York (large squat form); Roum. 1677/-/France; **PAV** Fuckel 1074/?/?; 307/-/Vosges?; 645/-/Germany; 775/-/?; **TRTC** ?/-/Maine; Banker/-/New York; Coll. Emmons/-/Quebec; Coll. Jackson/-/New York; Macoun/-/Ontario; 42988/-/Ontario **UAMH** 3829/cow hoof/obtained from CBS; **UPS** Banker/-/New York; Degelius/-/Sweden. as *Leptostromatacearum crandali*: **NY** San Juan Mountains/-/California. as *Lycoperdon equinum*: **E** Brodeis?/-/?. as *Onygena caprina*: **HBG** O. Jaap/-/?. as *Onygena piligena*: **BR** 762/old wool bonnet/France (2 specimens); **E** Wat. 38/owl pellet/Scotland; (possibly *O. corvina*); **S** Quelet?/owl pellet/France? (2 specimens);Straper/rotten matting/Sonntagberg?; Romell. 1587/?/?; as *Onygena* sp.: **NYS** C. H. Peck/-/New York.

PECTINOTRICHUM Varsavsky and Orr, 1971
Mycopathol. et Mycol. Appl. **43**:229.

Type species: *Pectinotrichum llanense* Varsavsky and Orr.

Ascomata: yellowish white when young, brown at maturity, globose, 250-450*u*m diam. **Ascospores:** hyaline or pale yellow, globose to ovoid, smooth, 2.8-3.5 x 3.1-3.5*u*m **Asci:** globose, 4.2-5.4*u*m, 8-spored. **Peridial hyphae:** septa enlarged, wall thick and tuberculate, 3-6.7*u*m diam. **Appendages:** pectinate, curved, bifurcate or truncate; long appendages brown, asperulate to tuberculate, septate, straight, spine-like with pointed apices 30-70*u*m long, 5.5-9*u*m wide at base.

Anamorph: aleurioconidia. **Degrades:** keratin.

Notes: Varsavsky and Orr *op. cit.* suggest that this species is closely related to *Auxarthron* due to the presence of knuckle joints and elongate appendages; and to *Ctenomyces* because of keratinolytic capacities. They also suggest that *Pectinotrichum* might be an evolutionary forerunner of *Arthroderma*. I agree that it is probably closely related to *Auxarthron*.

Von Arx (1981a) suggests that the genus *Pectinotrichum* is synonymous with *Gymnoascus*. I have chosen to regard *Pectinotrichum* as a genus separate from others in the Onygenaceae. Morphologically it is closest to *Auxarthron*. It is maintained separate from *Auxarthron* due to the morphology of the anamorph which is a *Chrysosporium* rather than *Malbranchea*-like. The unusual pectinate organs on the peridium are also not found in any species of *Auxarthron*.

Pectinotrichum llanense Varsavsky and Orr, 1971 Mycopathol. et Mycol. Appl. **43**:231 FIG 1-8.

Figs 55b 61a,b,c

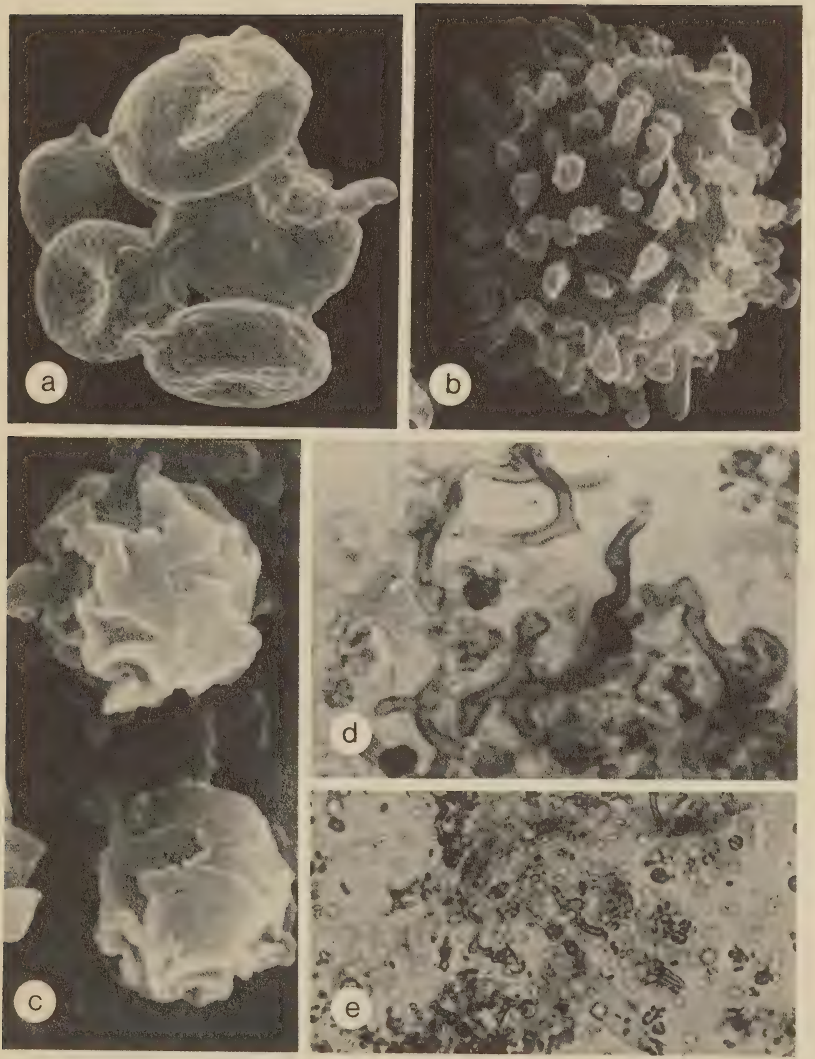
Type material: HOLOTYPE (*cultura desiccata*) **NY** LL8 (savannah soil, Venezuela).

Ascomata: pale yellow, becoming pale brown at maturity, 350-450*u*m diam. excl. appendages. **Ascospores:** pale yellow, smooth to very slightly roughened, oblate 2.58-3 - 3.1 x 3.5*u*m. **Asci:** globose, evanescent, 8-spored. **Peridial hyphae:** reticulate, enlarged at septa, mostly 3.5-4*u*m wide, pectinate formations directed toward the outside of the peridium. **Appendages:** long appendages - brown, tuberculate at base, apex smooth, curved or bent, flexuous with with many long lateral branches 550-590*u*m, 7.5-10.5*u*m at base; short appendages dark brown, tuberculate, straight and spine-like with pointed apices, 30-70*u*m long and 7.4-8.5*u*m wide at base. **Anamorph:** hyaline, smooth, bluntly pointed, pyriform aleurioconidia "of the *Chrysosporium* type" *fide* Varsavsky, 1.5-2.3 x 4.8-7.2(8)*u*m. **In culture:** [UAMH 3400]. CER 49/25°C cream, radiately fibrillose; reverse pale yellow; DSA 49/25°C abundant, dense, cream-colored mycelium, at hair, numerous light brown ascomata; PYE 49/25°C cream colored, zonate, dense growth, surface cracked; reverse orange-brown.

Notes: Known only from material isolated in Venezuela (7 isolates).

Material examined: NY (type as cited); O-779 (=UAMH 3401), O-3160 (=UAMH 3400)/soil/Venezuela; O-3501 (=UAMH

Fig. 66 a. *Shanorella spirotricha* (UAMH 4765). Oblate ascospores with fine, round puncta. X8280. b. *Renispora flavissima* (UAMH 4205). Large, globose, spiny macroconidium. X6120. c. *Arachnotheca glomerata* (UAMH 3551). Ascospores with membranous sheath. X10440. d. *Shanorella spirotricha* (UAMH 4765). Thick-walled, irregular, disarticulated hyphae of incompositoperidium. X900. e. *Shanorella spirotricha* (UAMH 4765). Elements of the incompositoperidium and ascospores as they appear in a squash preparation. X360.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3447)/human/?.

RENISPORA Sigler and Carmichael, 1979
Mycotaxon **10**:133-134.

Type species: *Renispora flavissima* Sigler, Gaur, Lichtwardt and Carmichael

Ascomata: yellow, spherical, to 200*u*m diam. (100-150*u*m) surrounded by wefts of hyphae with *Chrysosporium* conidia; heterothallic. **Asci:** mostly clavate, hyaline, 6-10*u*m diam. **Ascospores:** reniform or bacilliform, finely pitted, hyaline or yellow at maturity ±1-2 lipid droplets, mostly 2.5 x 4-5.5*u*m. **Appendages:** lacking. **Peridial hyphae:** poorly differentiated from vegetative hyphae, compactly intertwined, thin-walled, narrow, smooth or encrusted, hyaline or yellow. **Ascocarp initials:** hyaline, coiling about each other. **Anamorph:** *Chrysosporium*. **Degrades:** keratin.

Notes: Ascospores are very similar to those of *O. equina* in sculpturing and in the presence of guttules, but are smaller.

Renispora flavissima Sigler, Gaur, Lichtwardt and Carmichael, 1979 Mycotaxon **10**:133-134.
Figs 65a 66b

Type material: HOLOTYPE (*cultura desiccata*) **UAMH** 4205 (4140 x 4188) (bat guano, Kansas)

Anamorph name: *Chrysosporium* state of *Renispora flavissima*.

Ascomata: yellow, spherical, 30-200*u*m. **Ascospores:** reniform, or bacilliform, finely pitted, yellow at maturity often having 1 or 2 lipid droplets (2.2-)2.5(-3) x 4-5.5*u*m. **Asci:** short-stipitate, clavate, max. diam. not exceeding 10*u*m. **Peridial hyphae:** hyaline to yellow, poorly differentiated, thin-walled, narrow, smooth or encrusted. **Appendages:** lacking. **Anamorph:** aleurioconidia terminal ellipsoid to pyriform, becoming globose or subglobose, spiny or prominently tuberculate, 6-11(13)*u*m diam., sessile or on short or long branches; rarely 2 or 3 forming in succession; some arthroconidia. **In culture:** [UAMH 4210]. CER 28/25°C yellow to fawn, granular in centre; reverse concolorous. DSA 48/25°C orange or brownish yellow with discrete knots in centre; reverse concolorous. PYE 28/25°C bright golden yellow, granular; reverse dark orange- brown.

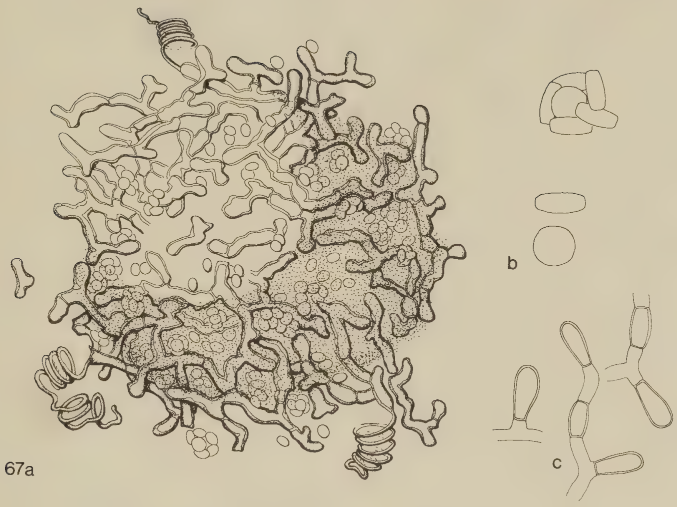
Notes: Keratinolytic, nonpathogenic, found only in bat guano and soil. Anamorph closely resembles the *Chrysosporium* state of *Ajellomyces capsulatus*. Gaur and Lichtwardt (1980) present an SEM study of conidiogenesis.

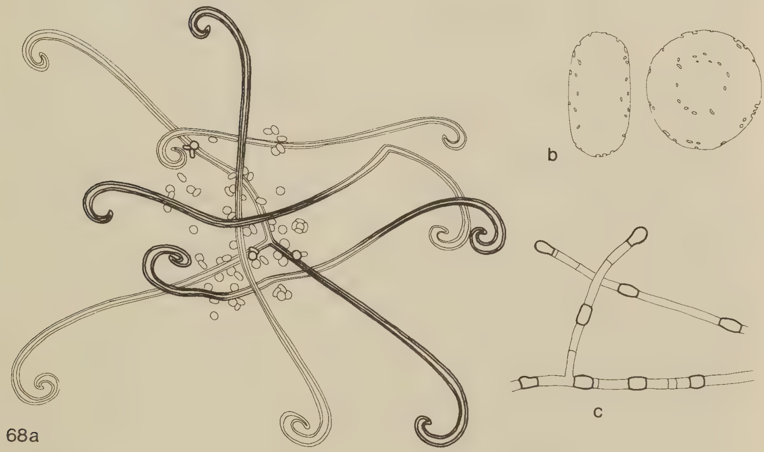
Material examined: UAMH 4140, 4141/bat guano/Kansas; 4184, 4185, 4187, 4191/bat soil/Kansas.

SHANORELLA Benjamin, 1956
Aliso 3:319.

Type species: *Shanorella spirotricha* Benjamin.

Ascomata: bright yellow to golden yellow, globose, thickly aggregated in cottony tufts, densely covered in white superficial mycelium. **Ascospores:** bright yellow, flattened,





Figs 67-68. 67. *Shanorella spirotricha* (RSA 156). a. Incompositoperidium of disarticulated, irregularly thick-walled, irregular cells. X470. b. Ascospores and conglobate ascal cluster. X1175. c. Anamorph of clavate, and oblong conidia. X1175. 68. *Uncinocarpus reesii* (UAMH 3882). a. Ascoma showing loose arrangement of appendages and ascospores. X315. b. Oblate, finely punctate ascospores. X3655. c. Anamorph of barrel-shaped, intercalary conidia. X550.

oblate, minutely pitted, <4*u*m maximum diam. **Asci:** hyaline, globose. **Peridial hyphae:** pale yellow, septate, thick-walled, smooth cells irregular, disarticulating at maturity, elongate; forming an incompositoperidium. **Appendages:** hyaline, septate, thin walled, slender, tips coiled. **Ascocarp initials:** coils. **Anamorph:** hyaline arthro- and aleurioconidia. **Degrades:** keratin.

Notes: The incompositoperidium resembles that of some *Gymnascella* species (e.g. *G. nodulosus*). The ability to break down keratin and the pitted ascospores are sufficient to place *Shanorella* in the Onygenaceae.

Shanorella spirotricha Benjamin, 1956 El Aliso 3:319-321.
Figs 66a,d,e 67a,b,c
Type material: HOLOTYPE (*cultura desiccata*) **RSA** 156 (feathers of a dead bird, California).

Ascomata: white at first, becoming yellow, grayish yellow or bright yellow, 100 - 600*u*m diam., globose, confluent or solitary, often gregarious under a common tomentum. **Ascospores:** bright yellow, oblate, thick-walled, 2.2-2.8 x 3.5-4.2*u*m, minutely roughened. **Asci:** 5.2-7.8*u*m, globose, evanescent. **Peridial hyphae:** pale yellow, septate, cells 3-15 x 10-35*u*m or more, straight, curved, simple or branched, nodulose, contorted, thick-walled (0.5-2*u*m). **Appendages:** fine, hyaline, septate helices, 1-1.3*u*m wide, with 20-30 gyres; helices may be 10-20*u*m wide and 25-40*u*m long, and originate as terminal or lateral outgrowths of peridial hyphae.Helices abundant, scarce or absent depending on strain. **Ascocarp initials:** robust irregular, septate coil, 15*u*m in length. **Anamorph:** terminal, lateral or intercalary, clavate or oblong conidia, 2-3.3 x 3.3-12*u*m, **In culture:** [UAMH 4765]. CER 21/25°C bright citrine yellow, with green tint in older portions, margin white, granular; reverse pale yellow. DSA 43/25°C greenish or brownish yellow in discrete knots; reverse concolorous. PYE 21/25°C white, cottony with pale yellow knots; reverse concolorous.

Notes: Since Benjamin's description of this species in 1956, there have been no further reports of its occurrence. I have found *S. spirotricha* to be one of the most common ascomycetes on carnivore dung particularly after four months of incubation. On natural materials, this species can form very large conglomerations of ascomata within a matrix of vegetative hyphae. These stromatic formations may be up to 2 cm or more in diam.

Material examined: RSA 156 (type as cited); 65 (=UAMH, 1970)/chicken feathers/Illinois; 1424 (=UAMH 3116)/owl

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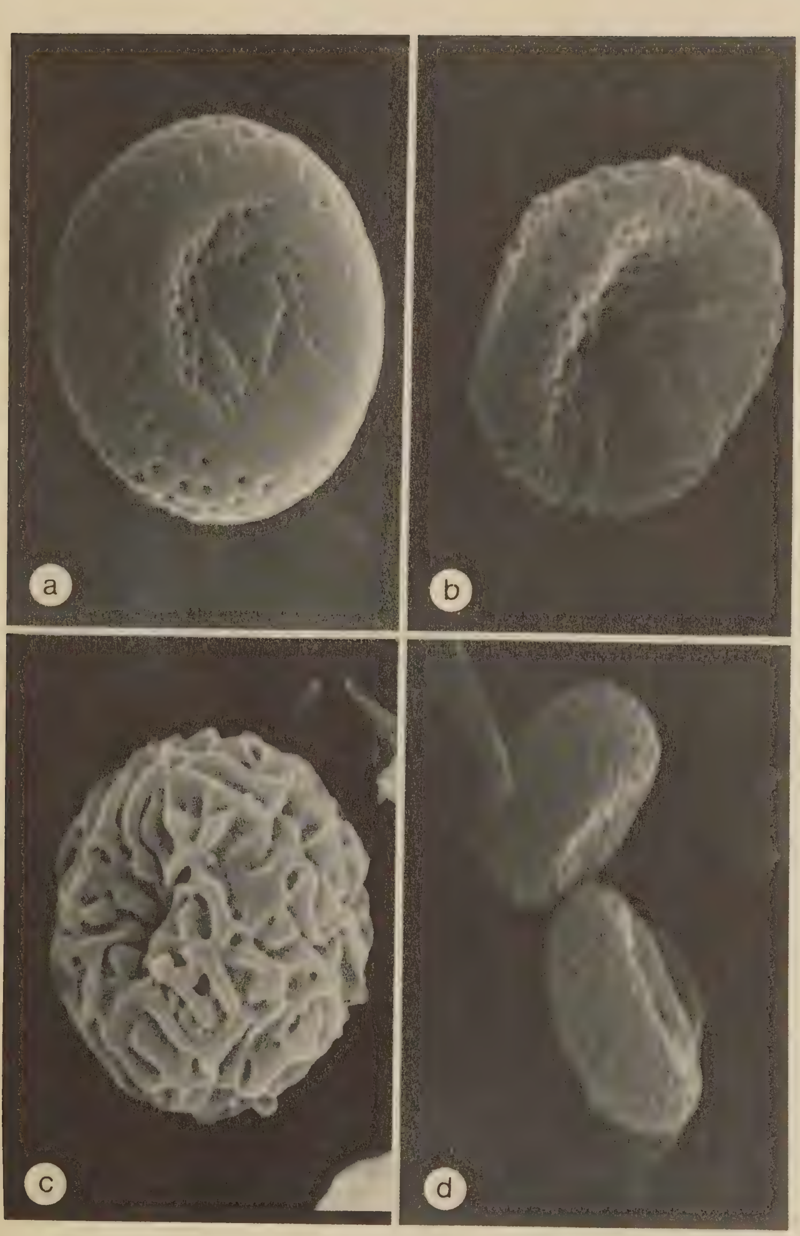
Fig. 69. a. *Uncinocarpus reesii* (UAMH 3882). Sparingly pitted, oblate ascospores. Puncta small, round; ridges very broad. X14400. b. *Uncinocarpus uncinatus* (TRTC 38215). Pitted, oblate (somewhat collapsed) ascospore. Puncta small and round. X14400. c. *Kuehniella racovitzae* (NY O-3436). Irregularly punctate, ridged, globose, somewhat collapsed ascospore. X16560. d. *Spiromastix warcupii* (UAMH 1668). Oblate ascospores with numerous minute pits. X14400.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pellet/Utah; **RSA** 1517/owl pellet/California; **NY** O-1009/soil/England; as *Arachniotus* sp.: **TRTC** 35218/carnivore dung/Ontario; as *Gymnoascus* sp.: **TRTC** C1197/rodent dung/Alberta; **UAMH** 4764/carnivore dung/Alberta; 4765/weasel dung/Alberta; 4772/coyote dung/Alberta.

SPIROMASTIX Kuehn and Orr, 1962
Mycologia **59**:160.

Type species: *Spiromastix warcupii* Kuehn and Orr.

Ascomata: brown, ovoid to spherical, 50-100um diam. excl. appendages. **Ascospores:** smooth, pale yellow-orange, ovoid, small, 2-2.5 x 2.5-2.9um. **Asci:** ovoid, 5-5.7 x 7-7.7um. **Peridial hyphae:** interwoven, branched, delicate, thin-walled, smooth, pale yellowish brown hyphae, 1.5-2.2um diam. **Appendages:** dark yellow, curved, unbranched, smooth-walled, slender and of ±uniform diam., walls approx. 1um thick. **Anamorph:** unknown. **Degrades:** keratin.

Notes: This is a beautiful genus which is known only from the type collection. The thick-walled, yellow, scimitar-shaped appendages resemble the disarticulated cells of *Shanorella spirotricha* in overall appearance.

Spiromastix warcupii Kuehn and Orr, 1962 Mycologia **54**:160 FIG 1-3.

Figs 69d 73b,d

Type material: TYPE STRAIN **UAMH** 1668 (wheatfield soil, Australia) (Possibly no holotype designated).

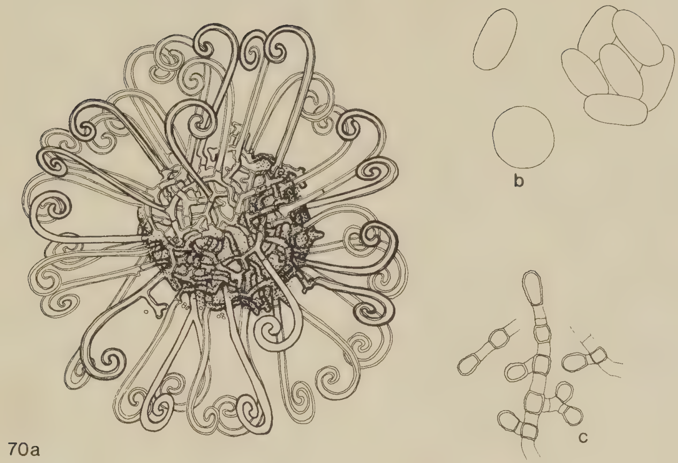
Ascomata: brown, ovoid to spherical, 50-100um diam. incl. appendages. **Ascospores:** light yellow, oblate, smooth, 2-2.5 x 2.5-2.9um. **Asci:** ovoid, 5-5.5 x 7-7.7um. **Peridial hyphae:** pale yellow-brown, closely interwoven, thin-walled, smooth, 1.5-2.2um. **Appendages:** dark yellow, smooth, thick-walled, slender, loosely curved, 1.1um diam. **Ascocarp initials:** small, variable, always arising from different parent hyphae. **Anamorph:** unknown. **In culture:** [UAMH 1668]. CER 42/25°C white, felty; reverse orange-brown. DSA 42/25°C white with brown central region (from cleistothecia); reverse yellow to cream. PYE 42/25°C pale yellowish white, dense; reverse orange-brown.

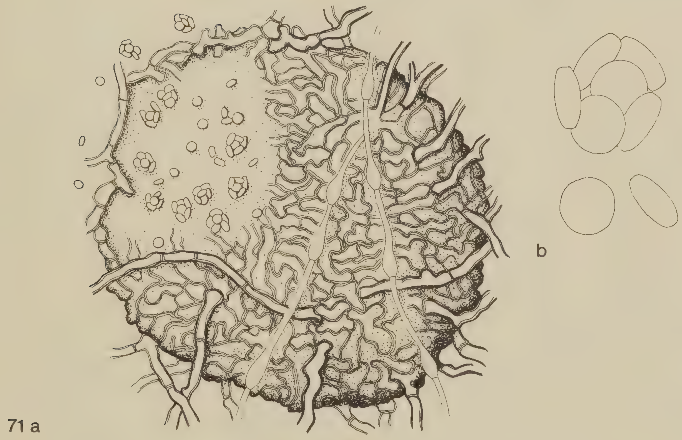
Material examined: Known only from the type. **NY, RSA, UAMH** 1668 (type as cited, =RSA 1293).

UNCINOCARPUS Sigler and Orr, 1976
apud Sigler and Carmichael, Mycotaxon **4**:462-464.

Type species: *Uncinocarpus reesii* Sigler and Orr.

Ascomata: reddish brown, globose, to 1000um diam. **Ascospores:** yellow-brown to red-brown, oblate, sometimes with a depression on one face, smooth, 2.5-3 x 4-5um. **Asci:** hyaline, short-stalked, subglobose, 7-9um. **Peridial hyphae:** reddish or orange-brown, roughened, thick-walled, and forming a reticuloperidium; or absent beyond the formation of thick-walled ±branched appendages. **Appendages:** red-brown, aseptate, smooth, thick-walled, occasionally helical, ±lateral, uncinate branches, 5-8um wide, tips wide, uncinate. **Ascocarp initials:** hyaline septate branches with





Figs 70-71. 70. *Uncinocarpus uncinatus* (RSA 56). a. Reticuloperidium with numerous thick-walled, uncinate appendages. X175. b. Oblate ascospores and ascal cluster. X1800. c. Roughened terminal and intercalary conidia. X785. 71. *Xynophila mephitalis* (TRTC 42886). a. Individual, naked, membranous ascoma. X535. b. Oblate ascospores, free and in a conglobate ascal cluster. X2485.

bulbous enlarged tips often completely inrolled. **Anamorph:** intercalary and terminal conidia. **Degrades:** keratin.

Notes: I have transferred *Gymnoascus uncinatus* here due to the similarities in appendage morphology and ascospore morphology. Both species have similar uncinate appendages and punctate ascospores. *Uncinocarpus uncinatus* is quite different from *Gymnoascus reessii* due to these onygenalean characteristics. *U. reesii* and *U. uncinatus* may be quickly distinguished on the basis of the appendages; those of *U. uncinatus* are thick and wide to the distal end and those of *Uncinocarpus reesii* taper to a point.

Uncinocarpus reesii Sigler and Orr, 1976 Mycotaxon 4:349-388, FIG 20A-K and 21A-J.

Figs 68a,b,c 69a 72c,e

Type material: HOLOTYPE **UAMH** 3882 (feathers, Australia).

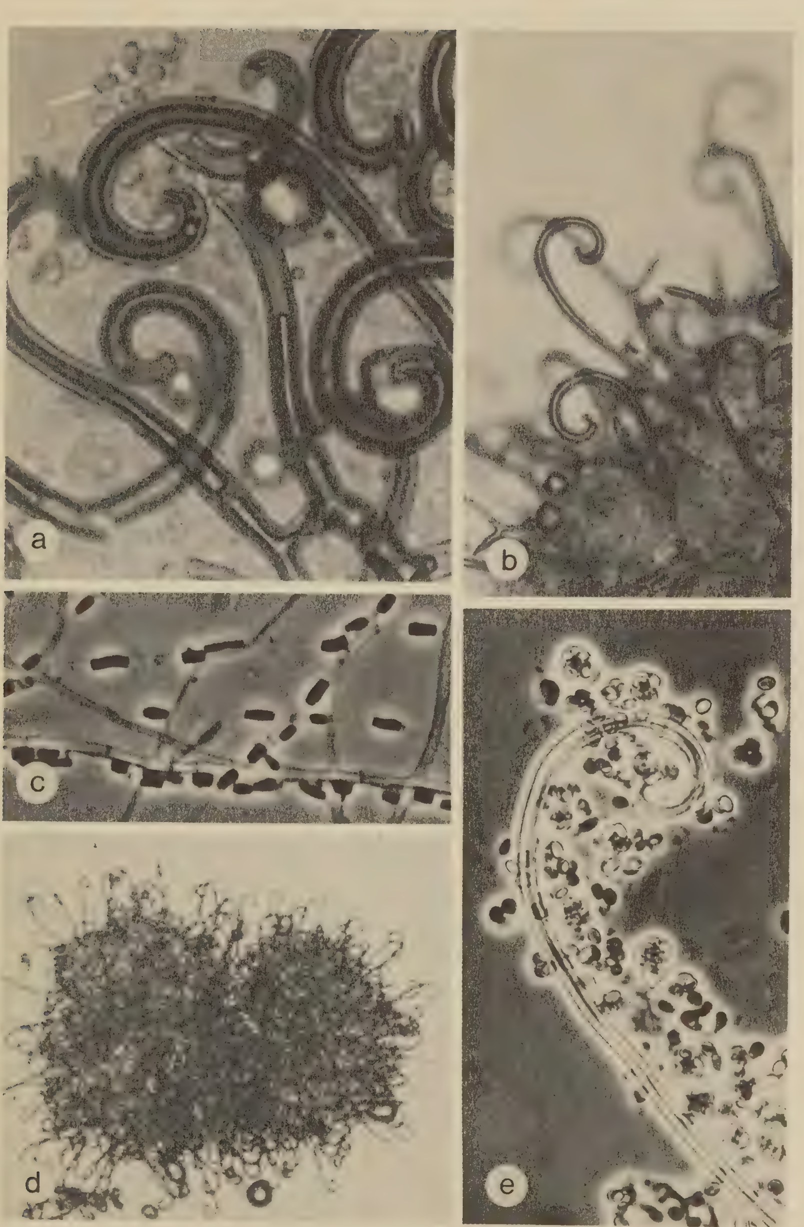
≡*Gymnoascus siglerae* Von Arx, 1981a.

Ascomata: reddish brown, ±globose, 200-1000um diam. excl. appendages, discrete. **Ascospores:** yellow-brown, reddish brown, minutely punctate, oblate, sometimes one face depressed, 2.5-3 x 4-5um. **Asci:** evanescent, ±globose, 7-9um diam., 8-spored. **Peridial hyphae:** lacking beyond the loosely intertwined appendages. **Appendages:** 100-250um in length, uncinate, aseptate, pale brown, becoming slightly wider at the tip, 5-8um. **Ascocarp initials:** heterothallic; short, septate branches, tip enlarged bulbous and often completely inrolled. **Anamorph:** arthroconidia hyaline becoming tan, barrel-shaped or cylindrical if intercalary; produced in association with uncinate appendages, smooth, mostly 2.5-3.5 x 3.5-6um **In culture:** [UAMH 3881]. CER 14/25°C yellowish, granular; reverse pale yellow. DSA 42/25°C irregular distribution brown knots of mycelium over a pale brown mat in vicinity of hair; reverse buff. PYE 14/25°C pale beige, slightly cottony; reverse orange yellow at margin.

Notes: Anamorph is frequently isolated during surveys of soil and keratinous materials. The teleomorph was described but never named prior to the treatment of Sigler and Orr (in Sigler and Carmichael, *op. cit.*) Von Arx (1981a) placed the type of *Uncinocarpus* in *Gymnoascus*. The punctate ascospores, keratinolytic capacities and the well-developed anamorph of *U. reesii* support its disposition as the type of a genus distinct from *Gymnoascus*.

Material examined: UAMH (*Malbranchea* state of *Uncinocarpus*

Fig. 72. a. *Uncinocarpus uncinatus* (FH hen dung). Smooth, thick-walled, uncinate appendages; ascospores (arrow) oblate, and apparently smooth. X515. b. *Uncinocarpus uncinatus* (FH hen dung). Tangential view of outer surface of ascoma. X220. c. *Uncinocarpus reesii* (UAMH 3703). Intercalary conidia of *Malbranchea* anamorph. X600. (Phase contrast photomicrograph). d. *Uncinocarpus uncinatus* (FH hen dung). Two interlocked ascomata. X365. e. *Uncinocarpus reesii* (UAMH 3882). Thick-walled, uncinate appendage with tapered distal end, and oblate ascospores. X600. (Phase contrast photomicrograph).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reesii) S160 (Emmons C3716)/*Silvilagus* sp./Texas; 1273/soil/Venezuela; 1704, 1706/soil/California; 1955/soil/Argentina; 2002, 2050, 2852, 2854, 3573, 3819, 3820/soil/Italy; 2845, 2862, 3484, 3485/feathers/Australia; 2855/soil/Hungary; 2991, 2992/clinical source/West Virgina; 3257, 3258/soil/India; 3703/soil/Utah; 3843/feathers/Czechoslovakia; 3846/nest/Czechoslovakia; 3881/-SAC from type.

Uncinocarpus uncinatus (Eidam) Currah, comb. nov.
Figs 69b 70a,b,c 72a,b,d 52d
Type material: PROPOSED NEOTYPE (*cultura desiccata*) **RSA** 56 (dung, California).
≡*Gymnoascus uncinatus* Eidam, Cohn, Beit. Biol. Pfl. 3:292, 1880 Taf XV, FIG 35-42. (Basionym).
≡*Myxotrichum uncinatum* (Eidam) Schroeter, KryptogamenFlora von Schlesiens 3:212, 1893.

Ascomata: yellow to orange-brown to red-brown, globose, 150-1150um diam. **Ascospores:** yellowish, oblate, 1.5-3.2 x 1.5-5.5um. **Asci:** globose to ovoid, 6-9.8um diam. **Peridial hyphae:** orange, reddish orange, smooth to roughened, interwoven, with a few blunt free ends, forming a reticuloperidium. **Appendages:** orange to reddish orange to brownish yellow, aseptate, 5-8.8 x 75-387um, uncinate, rarely branched, walls at base to 3um thick, remaining robust and wide to the distal end. **Ascocarp initials:** swollen antheridium surrounded by an ascogonial coil (mutually coiled equal gametangia, 23um long when coiled *fide* Benjamin, 1956). **Anamorph:** asperulate to minutely echinulate, terminal aleurioconidia and intercalary arthroconidia, 3-4.2 x 3.8-6.8um; becoming yellowish and thick-walled with age. **In culture:** [UAMH 3913]. CER 14/25°C pale yellow irregularly and sparsely felty; reverse orange brown in centre paling at margin. DSA 42/25°C yellowish white knots in vicinity of hair; reverse pale yellow. PYE 14/25°C yellow, cottony; reverse yellow to yellowish orange.

Notes: This is a striking species because of the numerous, wide, uncinate appendages adorning the reticuloperidium. It resembles *Auxarthron californiense* which also has well developed uncinate appendages. However, the ascospores of *A. californiense* have very broad puncta which are easily noted under the oil immersion lens. The ascospores of *U. uncinatus* appear almost smooth. Massee and Salmon (1902) noted that the spores of an isolate they called *Gymnoascus uncinatus* were minutely "asperous", possibly indicating that they were looking at *A. californiense*. Van Oorschot (1981) labelled the anamorph "*Chrysosporium merdarium*" but the conidia appear quite different to me and apparently have no binomial. Twentyseven strains of *C. merdarium* are held at UAMH and none of these has developed a teleomorph and none is keratinolytic. The species are obviously unrelated.

Material examined: UAMH 3913 (strain derived from proposed neotype). **FH, TRTC** Thaxter 509/chicken dung/Connecticut; Thaxter 591/dog dung/Connecticut; **MICH** Povah?/deer dung/Michigan; **RSA** 56/(proposed neotype as cited); 425/owl pellet/California; 460/frog(?) dung/California; as *Gymnoascus* sp.: **FH, TRTC** Piquet/chicken bones/Mass. as

Myxotrichum sp. or *Myxotrichum uncinatum*: **DAOM** 12409/rat dung/Kansas; **TRTC** 66.3172c/Hyrax dung/Uganda; 6537/dung/Ontario; 38215/carnivore dung/Ontario; Nashville/raccoon dung/Ontario.

XYNOPHILA Malloch and Cain, 1971
Can. J. Bot. **49**:845-846.

Type species: *Xynophila mephitalis* Malloch and Cain

Ascomata: clustered within a dense, white, tomentose layer of hyphae; orange or brown, subglobose to globose, 150-300*u*m diam. **Ascospores:** oblate, yellow to yellow-brown, 2-3 x 3-4*u*m, smooth to minutely roughened. **Asci:** subglobose to globose, 6-12*u*m diam., and borne on croziers. **Appendages:** lacking. **Peridial hyphae:** membranous layer of reddish brown, polygonal cells. **Anamorph:** smooth, hyaline arthroconidia 2-5 x 5-15*u*m, pyriform to cylindrical or irregular in shape, nonseptate to multiseptate, simple or branched, hyaline or smooth; infrequent. **Degrades:** keratin.

Notes: This genus appears to occupy a transitional position between *Onygena* and cleistothecial species, such as *Aphanoascus* and *Keratinophyton*. It forms many individual cleistothecia within a woolly mass of hyaline vegetative hyphae. The entire structure could be regarded as a stroma. *Ascocalvatia* is similar but the ascospores of *A. alveolata* are cylindrical rather than oblate.

Xynophila mephitalis Malloch and Cain, 1971 Can. J. Bot. **49**:845-846 FIG 1-10.

Figs 1d 55a 71a,b 73a,c

Type material: HOLOTYPE (*cultura desiccata*) **TRTC** 42886 (wolf dung, Ontario).

Ascomata: yellow-orange to brown, globose, 50-300*u*m diam. clustered within a white arachnoid mass of hyphae. These compound structures may be up to 1cm diam. **Ascospores:** yellow-orange to orange brown, smooth to minutely roughened, 1.8-3 x 3-4*u*m, conglobate. **Asci:** globose to subglobose, 6-12*u*m, 8-spored. **Peridial hyphae:** orange-brown, cells 2-4 x 3-20*u*m, forming a membranous layer; outer hyphal covering white and most developed on natural substrate; poorly differentiated when grown on agar cultures. **Anamorph:** arthroconidia pyriform to cylindrical, 0-multiseptate, simple or branched, smooth, 2-5 x 5-30*u*m, not numerous. **In culture:** [UAMH 3849]. CER 21/25°C orange brown to buff brown, concentrically zonate; reverse yellowish brown. DSA 42/25°C greenish buff localized in vicinity of hair; reverse yellowish orange. PYE 14/25°C yellowish cream, velvety growth; reverse orange-brown. (Ascomata formed in abundance on OAT).

Notes: This distinctive species is first detected by the strong skunk-like odour that it produces. It forms small, white tufts on the surface of dung samples; the tufts may eventually be 1cm diam. On agar media, these complex structures do not form. Instead, the membranous cleistothecia form individually.

Material examined: **TRTC** 42886, (holotype as cited); 45338/raccoon dung/Ontario; 32268/skunk dung/Ontario; **UAMH**

3849 (type strain as cited).

GENERIC NAMES NOT ACCEPTED IN THE ONYGENALES

The following is a list of generic names which have, at one time or another, been referred to either the Gymnoascaceae or Onygenaceae. The names are given with a brief note explaining why they are excluded, or they are equated with a name accepted herein.

Actinodendron Orr and Kuehn, 1963 (Mycopathol. et Mycol. Appl. 21:211). Name applicable to teleomorph of fungus with *Oncocladium* and *Malbranchea flava* anamorphs if ascospores are found.

Actinospira Corda, 1854 (Icones Fungorum 6:7). ≡*Myxotrichum* q.v.

Anixiopsis Hansen, 1897 (Botanische Zeitung 7:131). ≡*Aphanoascus*.

Arachnomyces Massee and Salmon, 1902 (Ann. Bot. 16:68). Ascospores apparently smooth; gametangia strikingly different from all other Onygenales.

Arachnotheca von Arx, 1971 (Persoonia 6:376). Anamorph has schizolytically dehiscing arthroconidia, ascospores have membranous sheath.

Ascosphaera Olive and Spiltoir, 1955 (Mycopathol. et Mycol. Appl. 47:238). Sexual apparatus a trichogyne; ascospores formed within a spore cyst. Considered in its own class by Barr, 1983.

Byssochlamys Westling, 1909 (Svensk. Bot. Tidskr. 3:134). Anamorph phialidic (in form-genus *Paecilomyces*).

Carpenteles Langeron, 1922 (Compt. Rend. Soc. Biol. (Paris) 87:343). Anamorph phialidic (in form-genus *Penicillium*).

Campsotrichum Ehrenberg, 1819 (Jahrb. Gewachsk. 1:55). *Nomen invalidum* see Hughes, 1968 for discussion.

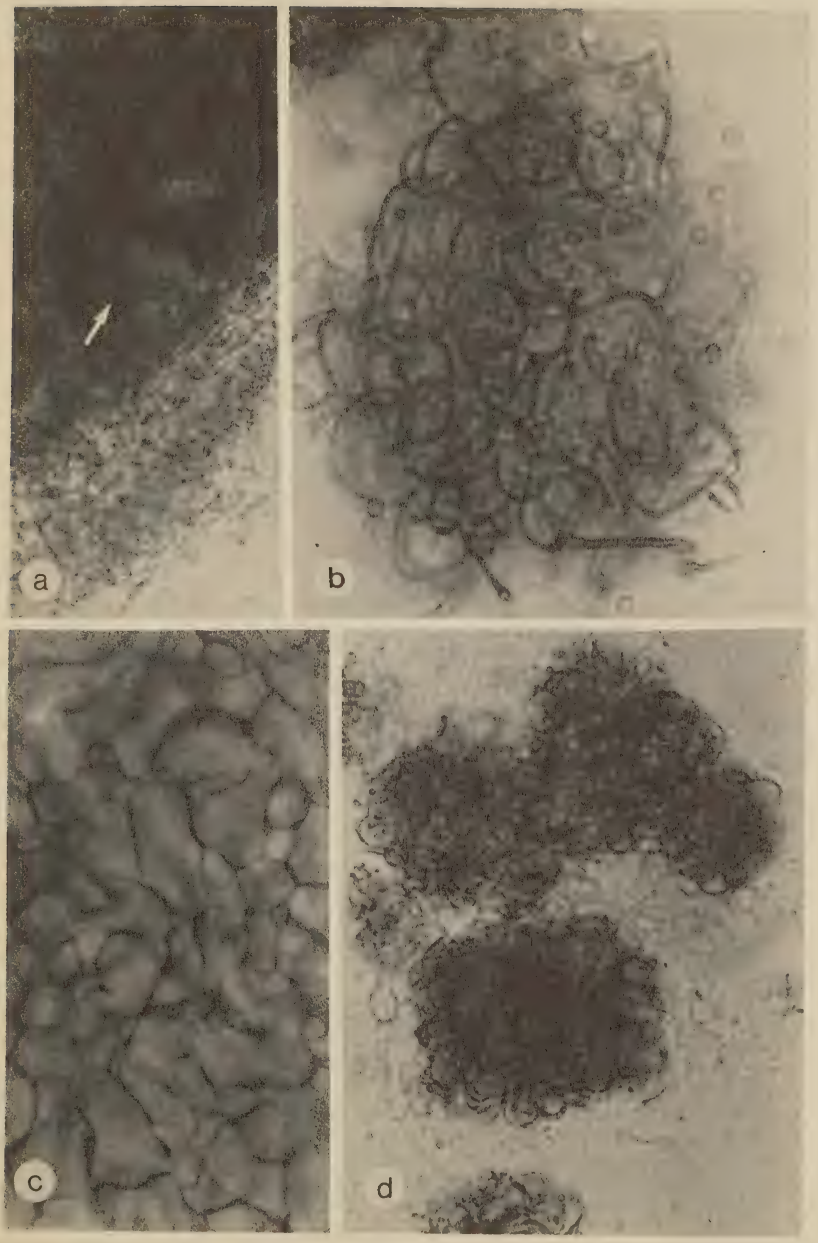
Conidiascus Holterman, 1898 (Myk. Unters. Trop. page 23). Endomycetales *fide* Benjamin, 1956.

Dichotomomyces Saito ex Scott, 1970 (Trans. Brit. mycol. Soc. 51:313). Placed in Onygenaceae by Malloch and Cain, 1970b; anamorph of schizolytically dehiscing blastoconidia.

Dichotonium Berkeley and Curtis, 1875 (Grevillea 3:146). Orthographic error. Hyphomycete genus *Oichitonium* see Carmichael *et al.*, 1980.

Diehliomyces Gilkey, 1954 (Mycologia 46:789). Smooth,

Fig. 73. a. *Xynophila mephitalis* (UAMH uncatalogued). Free hand section of fruit body showing outer tomentose layer of hyphae and inner conglomeration of ascospores (arrow). X900. b. *Spiromastix warcupii* (RSA 1293). Ascoma with a peridium of thick-walled, curved hyphae. X1080. c. *Xynophila mephitalis* (UAMH uncatalogued). Membranous peridium. X1330. d. *Spiromastix warcupii* (RSA 1293). Ascomata of various sizes; nearly confluent. X290.


a
b
c
d

SEE ERRATA

globose, thin-walled ascospores.

Diplostephanus Langeron, 1922 (Comp. Rend. 87:344). *Eurotium* teleomorph of *Aspergillus fide* Thom. See Ainsworth, 1961.

Disarticulatus Orr, 1977 (Mycotaxon 6:33). based on *Gymnascella devroeyi* q.v.

Eidamella Matruchot and Dassonville, 1901 (Bull. Soc. Mycol. Fr. 17:129). =*Myxotrichum deflexum* q.v.

Eleutherascus von Arx, 1971 (Persoonia 6:77). Large spiny ascospores to 12um diam.; no anamorph. "Primitive discomycete" (von Arx) *op. cit.*

Emmonsiella Kwon-Chung, 1972 (Science 177:368). =*Ajellomyces* q.v.

Galactomyces Redhead and Malloch, 1977 (Can. J. Bot. 55:1701). Schizolytically dehiscing arthroconidia; ascospores with furrow.

Hexagonella Stevens and Guba, 1925 (Bish. Mus. Bull. 19:89). Epiphyllous on *Pellaea rotundifolia* (Pteridophyte) and large, 3-celled ascospores.

Leucothecium von Arx and Samson, 1973 (Persoonia 7:378). Arthroconidia dehisce schizolytically.

Lilliputia Boudier and Patouillard, 1900 (Bull. Soc. Mycol. Fr. 16:144). =*Roumeguerielia fide* Malloch and Cain, 1972a (in Trichocomaceae) see Benny and Kimbrough, 1980.

Macronodus Orr, 1977 (Mycologia 5:283, 1977). =*Auxarthron* q.v.

Myrillium Clements and Shear, 1931 (*Species incertis est.*) (see Benjamin, 1956).

Narashimella Thirumalachar and Mathur, 1966 (Sydowia 20:184). =*Gymnascella marginospora* q.v.

Penicilliopsis Solms-Laubach, 1887 (Ann. Jard. Buitenz. 6:53). "usually included in the Eurotiaceae" (Benjamin, 1956).

Petalosporus Ghosh, Orr and Kuehn, 1963 (Mycopathol. et Mycol. Appl. 21:36). =*Gymnascella* q.v.

Pleuroascus Massee and Salmon, 1901 (Ann. Bot. 15:330). Possibly Onygenaceae; excluded here until further study.

Plunkettomyces Orr, 1977 (Mycotaxon 6:33). =*Gymnascella* q.v.

Pseudoarachniotus Kuehn, 1957 (Mycologia 49:694). =*Gymnascella* q.v.

Rollandina Patouillard, 1905 (Bull. Soc. Mycol. Fr. 21:81). =*Nomen confusum.*

Thermoascus Miehe, 1907 (Die Selbsterhitzung des Heues, Jena pp 70-73). Placed in Onygenaceae by Benny and Kimbrough, 1980; excluded here since there is no evidence of keratinolytic abilities nor, does it have strictly rhexolytically dehiscing conidia.

Toxotrichum Orr and Kuehn, 1964 (Mycologia 56:473). =*Myxotrichum.*

Tripedotrichum Orr and Kuehn, 1964 (Mycologia 56:482). Dark oblate ascospores described by Orr are probably conidia of dematiaceous hyphomycete.

Waldemaria Batista, Maia and Cavalcanti, 1960 (Atas. Inst. Micol. (Recife). 1:6. =*Gymnascella* q.v.

Xanthothecium von Arx and Samson, 1973 (Persoonia 7:377). Possibly Onygenales; decision reserved until further study.

Xylogone von Arx and Nilsson, 1969 (Svensk. Bot. Tidskr.

63:345). Schizolytically dehiscing arthroconidia.

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SOME INTERESTING HYPHOMYCETES FROM WATER

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Two new species of aquatic hyphomycetes from foam and an aero-aquatic from submerged decaying bark are described and illustrated. Description of an aero-aquatic, synnematous hyphomycete, yet unpublished is also given.

Whilst searching for aquatic hyphomycetes from foam and on submerged decaying plant material, two recent collections yielded several interesting hyphomycetes, some of which appear to be undescribed. The purpose of this communication is to describe and illustrate three of these species. A description of an aero-aquatic, synnematous hyphomycete found on submerged leaves is also included. This same fungus will be formally described elsewhere by Shaw and Sutton based on their collections from Papua New Guinea and Australia.

Diplocladiella tricladioides sp. nov. (Fig.1)

Mycelium partim superficiale, partim in substrato, levibus, fuscis vel brunneis, ramosis, septatis, 2-3 µm latis hyphis. Conidiophori dispersi, singuli, macronemati, simplices, septati, flexuosi vel dejecti, leves, brunnei et in apice brunneoli, 24-40 x 3.5 -4 µm. Cellulae conidiogenae integratae, terminales, geniculatae, sympodiales, cicatricibus conidiorum in geniculationibus rotundatis. Conidia solitaria, obpyramidalia, fusca vel atrogrisea, symmetrica, 20-23 µm longa, octocellularia, singulari restricta truncata basali cellula, 4 crasso-tunicatis medialibus cellulis et 3 similibus, singulo, longo tenui, hyalino, simplice, 38-48 x 1.5 µm appendice praeditis apicalibus cellulis composita.

Habitat saprophytice in cortice decidui trunci in Gombak flumine immersi, Malaya Universitatis, Regionale Studiorum Centro, Augusto 1984, A. Nawawi (IMI 289094 = UM 5-84, holotypus).

This aero-aquatic fungus was found growing and sporulating on a piece of decaying bark in moist chamber. The bark was taken from a submerged log of an unidentified tree along Gombak river. On incubation at 20° C in a Petri dish with some water, the fungus sporulated continuously for more than a month. Conidia were formed just above the water meniscus, with their long, thin glistening appendages

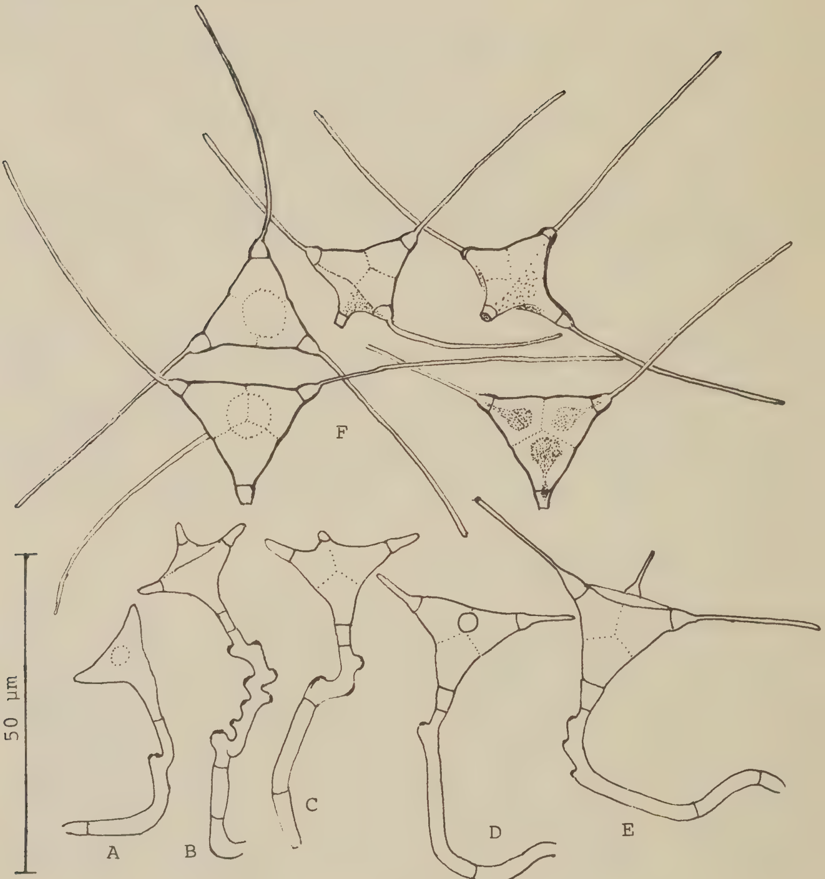

Fig. 1. *Diplocladiella tricladioides*. (A - E). Conidiophores with conidia at different stages of development arranged in a developmental series; (F) Conidia.

radiating out.

The mycelium was partly superficial, partly immersed in the bark tissue, composed of smooth, fuscous to brown, branched, septate, 2 - 3 µm wide hyphae. Conidiophores scattered arising singly, macronematous, unbranched, septate, flexuous to pendent, smooth, brownish, paler at the apex, 24 - 40 µm long x 3.5 - 4 µm wide. Conidiogenous cells integrated, terminal, geniculate, sympodial, cicatrized, conidial scars situated on rounded shoulders. Conidia solitary, obpyramidal, fuscous to dark grey, with sides of equal length, 20 - 23 µm, 8-celled; the main body consisting of 4 thick-walled cells, with a small truncate basal cell and three apical cells of the same size, each ending in a long, thin, hyaline, non-septate appendage, 38 - 48 µm x 1.5 µm. The apical cells are bell-shaped and their walls are thickened half-way. Conidia are released by a break in the basal septum. Detached conidia generally float due to the presence of trapped air bubbles in the central cells. Conidia are readily picked out with a fine needle or mounted eyelash. They germinate very slowly by producing a germ tube through the basal cell. On 2% MA the colony is dark-brown to black, restricted, with most of the mycelium immersed. Sporulation has not been observed to occur even when strips of colonies were placed in water.

This fungus superficially resembles *D. scalaroides* Arnaud apud M.B. Ellis (1976) in its conidial ontogeny and the sympodially proliferating conidiophores. Conidia are also 8-celled, thick-walled, brown and their two apices bear long, non-septate, hyaline appendages. However, conidia of *D. scalaroides* are triangular, not pyramidal.

Dwayaangam dichotoma sp. nov. (Fig.2)

Coloniae lente crescentes in agaro malto, ex hyalina ad cremeam vel castaneam colorem. Mycelium in substrato, hyphis hyalinis, ramosis, 2-3 µm latis, interdum monilioidis. Conidiophori dispersi, micronemati, curti, leves, ex hyphis ennati. Conidiogenae cellulae terminales, distinctae, determinatae, monoblasticae, usque ad 18 x 1.5-2.5 µm. Conidia solitaria, schizolytica, staurospora, hyalina, multicellularia, 70-85 µm in longitudine, basali parte truncata, cylindricea, 2-4 septata, 20-32 x 2.5-3 µm, apicaliter bifurcata, ramis duobus curtis, 5-11 µm, cylindraceis, 0-2-septatis et apicaliter denuo bi- vel trifurcatis, terminalibus ramis longis, divergentibus, subulatis, 4-7-septatis, 28-38 x 2.5-3.5 µm.

Habitat in spuma in rivulo, Cameronis Montibus, Maio 1984, A. Nawawi (IMI 289096 = UM 7-8, holotypus).

This striking fungus was isolated from foam of a small stream in the Cameron Highlands Malaysia. Conidia germinated readily producing germ tubes from their apices, but subsequent growth was very slow. On 2% MA the colony was restricted, colourless at first, becoming beige and finally

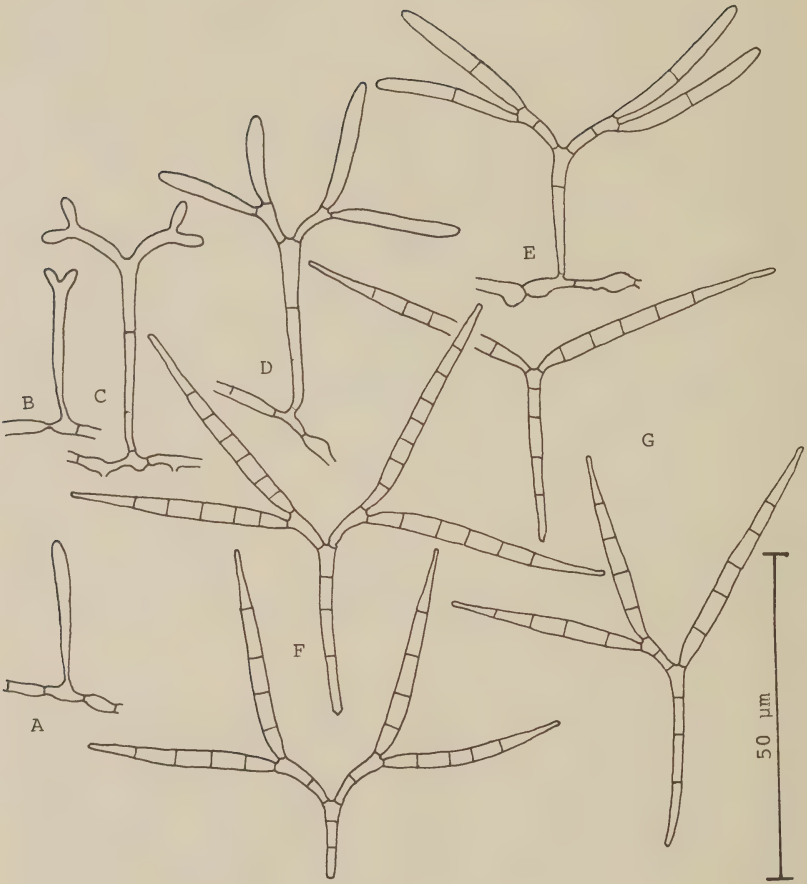

Fig. 2. *Dwayaangam dichotoma.* (A - E). Conidiophores with conidia at different stages of development arranged in a developmental series; (F). Typical conidia; (G) Conidia with two and three arms.

chestnut brown with a slight mound in the centre. Mycelium mostly immersed, hyphae 2 - 3 µm wide, branched, septate, hyaline and occasionally monilioid. One month old colonies at 20°-23° C reached 8 mm in diameter. No sporulation occurred on dry agar. Slivers of colonies submerged in sterile distilled water and aerated developed conidia sparingly after 5 - 7 days.

Conidiophores are micronematous, scattered, usually very short smooth processes developing from hyphal cells. Conidiogenous cells apical, discrete, monoblastic, determinate up to 18 µm x 1.5 µm wide. Conidia solitary, staurosporous, hyaline, multicellular, spanning 70 - 85 µm. Each consists of a truncate, cylindrical, 2 - 4 septate main axis, 20 - 32 µm long x 2 - 3 µm at the widest. Axis branched dichotomously at the apex, at an angle of 95° - 140° giving rise to 2 short arms, 5 - 11 µm long, 0 - 2 septate, lying in the same plane as the axis. The apices of these arms branched again dichotomously, resulting in a 5-spiked conidium. These terminal branches are 28 - 38 µm long x 2.5 - 3.5 µm at the widest, narrowly obclavate, 4 - 7 septate, lying in different plane to the rest of the conidium. Release is by a break in the basal septum. Mounted conidia invariably have all their arms lying in one plane.

This fungus appears to be confined to the highlands as it has never been encountered in foam samples from lowland streams. The morphology of the conidium is unique among aquatic hyphomycetes in that conidial branching is strictly dichotomous. The genus *Dwayaangam* was erected by Subramaniam (1977) for a single species, *D. quadridens* based on *Triposporina quadridens* Drechsler. The present fungus is close to the type species in conidial morphology but it differs in having arms that are constricted at their point of attachment. A second species *D. cornuta* Descals has been described from England (Descals & Webster (1982).

Lambdasporium viridense sp. nov. (Fig.3)

Coloniae lente crescentes in malto agaro, 10 mm per 40 dies in 20° - 23°, restrictae, leves, mycelio superficiale sparso, cyaneo-virides vel glaucae, marginato albae. Conidiophori numerosi, ex hyphis ennati, micronemati, curti, simplices vel parce ramosi, uni- vel paucicellulares. Conidiogenae cellulae terminales, monoblasticae, flexuosae vel sinuosae, sympodialiter proliferantes. Conidia triradiata, axiale parte curvata, attenuata, 2-4 -septata, 28-40x2.5 µm, laterale ramo recto vel parum curvato, singulare non constricto, attenuato, non septato, 7-13x2-2.5 µm, ad 80°-110° angulum antroso et in uno plano.

Habitat in spuma in rivulo, Cameroni Montibus, Maio 1984. A. Nawawi (IMI 293443 = UM 8-84, holotypus).

This fungus originated from a single conidium found in foam of a small stream in the Cameron Highlands. Germination was apical and preceded by considerable swelling of the

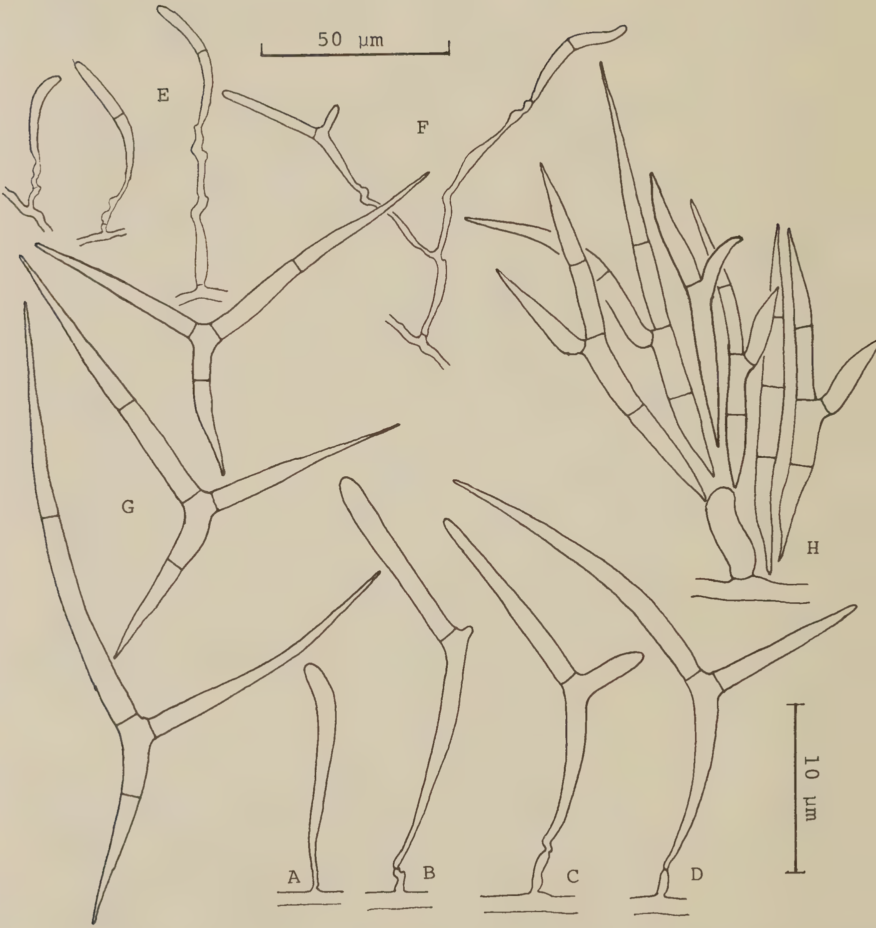
50 µm
E
F
G
H
A
B
C
D
10 µm

Fig. 3. *Lambdasporium viridense*. (A - F). Conidial ontogeny; (G). Three typical conidia; (H). *Volucrispora graminea*. A cluster of conidia developed in culture (English isolate).

conidium. On 2% MA the colony was slow-growing, restricted, smooth, with scanty aerial mycelium, blue-green to glaucous with a white, narrow incurved margin; diameter reaching 10mm in 40 days at 20° - 23°C. Sporulation occurred abundantly on agar, with or without immersion in water. Conidiophores numerous along mycelial hyphae, micronematous, simple or sparsely branched, cells 1 to few. Conidiogeneous cells single, apical, monoblastic, flexuous to wavy, detachment scar denticulate, proliferation sympodial. Conidia acrogenous, tri-radiate, main axis 28 - 40 µm x 2 - 2.5 µm, 2 - 4 septate, curved and attenuated. Lateral arm single, attenuated, non-septate, straight to slightly curved, 7 - 13 µm x 2 - 2.5 µm, antrorse at 80° - 110°, in one plane, not constricted at point of origin.

The genus *Lambdasporium* was introduced by Matsushima (1971) for a single species *L.wauense* Matsushima found on decaying leaves from Papua New Guinea. There have been no subsequent additions. The present fungus generally fits the generic circumscription of *Lambdasporium.* It differs from the type species in several aspects. *L. wauense* produces brownish colony and forms its conidia on very short conidiophores. Conidia are larger; the main axis subulate, convex, 3 - 8 septate and 30 - 80 µm long x 2.5 - 5 µm wide with slight constriction at each septum. The single lateral arm is 0 - 3 septate and not attenuated.

In terms of conidial morphology, there is some resemblance between *L. viridense* and *Volucrispora graminea* Ingold, McDougall & Dann (1968), whose conidia are very frequently seen in foam samples from European streams. However, *V.graminea* forms its conidia in clusters on definite conidiophores (Fig. 3, H).

Figure 4 shows an interesting synnematous aero-aquatic hyphomycete found on decaying leaves collected from a stream at Maxwell Hill, Taiping. Conidia of this fungus were often seen in foam samples from several locations earlier. By a coincidence this fungus has also been collected and studied by Dr. D. Shaw from Papua New Guinea and Australia and is to be formally described soon by Shaw & Sutton (1985) as a new genus. They have proposed the name *Setosynnema isthmosporum.* The description given below is based on the Malaysian isolate.

Pieces of submerged decaying leaves incubated in water developed synnemata readily within 5 days. They usually developed on the exposed portions of the leaves. Synnemata are stout, dark, erect, cylindrical, occasionally branched, 30 - 1600 µm high, composed of parallel, closely packed brown hyphae, with an expanded spore producing head, furnished with a fringe of long, straight to slightly curved, smooth, thick-walled setae, 8 - 17 in number, 12 - 17 septate, 58 - 100 µm long x 5 - 7 µm at the swollen base, narrowing to 2 µm at the tip. Synnemata that developed below water had longer shafts to traverse the water and sporulated some distance above the water meniscus. Many synnemata were observed to proliferate. This occurred when more water was

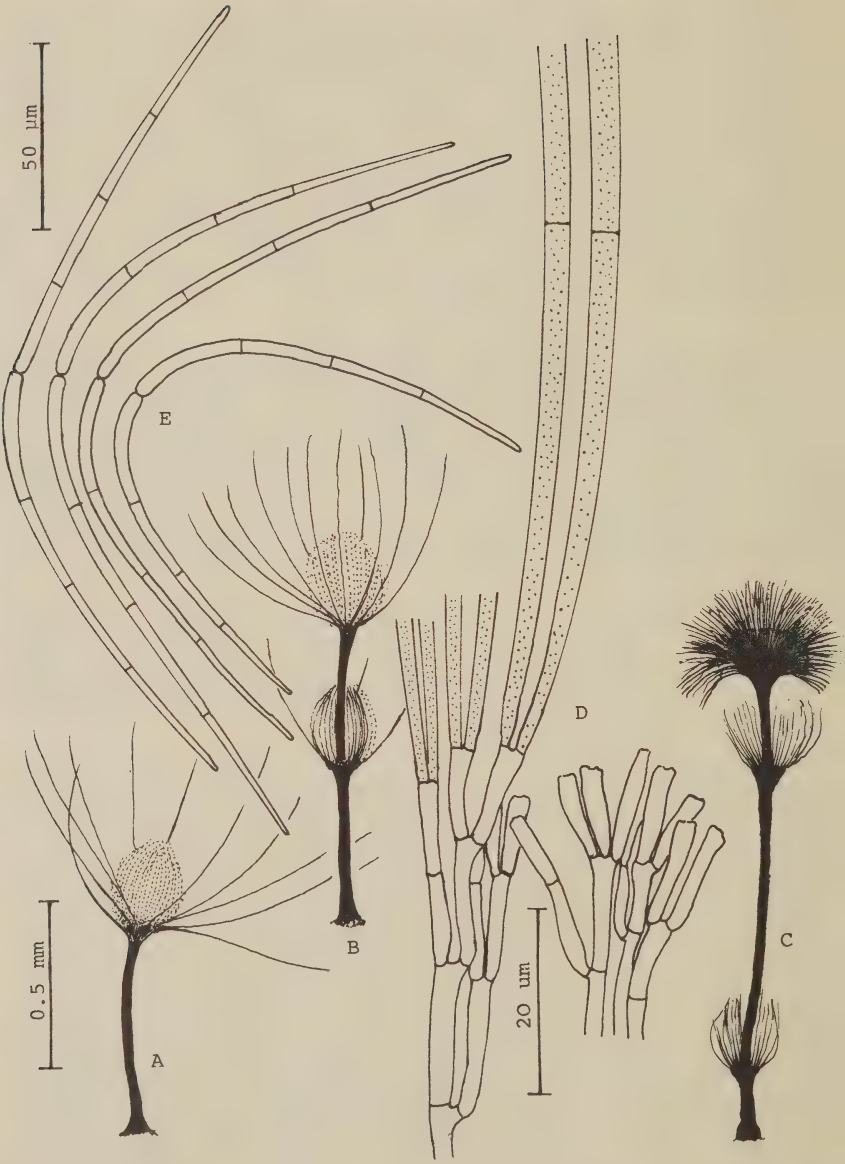

Fig. 4. *Setosynnema isthmosporum*. (A - B). Two synnemata from leaves, one with two conidial heads; (C). A synnema with three conidial heads developed in water culture; (D). Conidiophores and developing conidia (stippled); (E). Conidia.

added to the dishes. The bundle of hyphae in the centre of the sporiferous head lengthened and produced another sporiferous head above the new water level complete with another set of setae. Sometimes three such sporiferous heads have been observed to form on a synnema.

Conidiophores are repeatedly and closely branched, penicillate, septate, smooth, pale. Conidiogenous cells polyblastic, integrated, hyaline to pale fuscous, cylindrical 9 - 12 µm with their apices somewhat rounded and denticulate. All conidia on any head develop more or less synchronously. The developing conidia are at first straight, filiform, non-septate with rounded tips. Soon they bend slightly, their apices become narrower and the middle septa appear. These septa are clearly visible in a whole mount of a sporiferous head appearing as a distinct arc in the conidial cluster. As the conidia mature, more septa are laid down and the conidia curve inward, resulting in a white compact cluster in the form of a rugby ball. Conidia secede by a break in the narrow isthmus connecting the conidium and its conidiogenous cell, leaving minute scars on it. Upon release in water the conidia become U or bow-shaped, lying in different planes, some appearing sigmoid or helical and showing no distinction between the distal and the proximal end. They are 109 - 139 µm long x 3.5 - 4 µm at the widest, 7-septate with a distinct constriction at the middle septum and vacuolated. Whole mounts of conidial heads clearly show that the distance from the bases of the conidia to the constricted septa is slightly shorter than the distance from their tips. Measurements made on several straight, detached mature conidia show that the average distance from the tip and base to the constricted septa are 65.5 µm and 60 µm respectively, thus indicating that the constriction is not truly central. Several conidia were observed to have 2 of their adjacent septa constricted. In spite of the very narrow constriction, conidia appear to retain their shape and are not readily snapped.

Conidia germinated readily in water producing germ tubes from both ends of their apices. On 2% MA the colony was of moderate growth, black with grey fluffy mycelium. Synnemata were formed sparingly on this medium, but on the medium LCA modified after Miura & Kudo (1970) sporulation was more profuse. Synnemata formed on dry agar were thinner, and longer bearing few or no setae. When slices of a colony on LCA were placed in shallow water, fructification was profuse. Synnemata formed below water were less pigmented to almost colourless, up to 1.7 mm long and without setae. Those formed on or above the water level were darker and similar to those formed on the leaves. Conidial shape and size were comparable to those formed on the substrate.

The characteristic feature of this fungus is the dark synnema bearing a fringe of long, thin setae subtending the conidial head and producing filiform, bow-shaped, hyaline, 7-septate conidia with a distinct central constriction.

I am grateful to Dr. B.C. Sutton of C.M.I. for comments on the identity of the fungi described in this paper, and for sending me a copy of the manuscript on *Setosynnema isthmosporum.* My thanks to Professor G.L. Hennebert, Catholic University, Louvain for kindly translating the Latin diagnoses.

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THE SOUTH AMERICAN COLLECTIONS OF HYMENOCHAETE LEV. (APHYLLOPHORALES) IN J. RICK'S HERBARIUM.[1]

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SUMMARY

One hundred and one South American collections of *Hymenochaete* deposited in J. Rick's Herbarium at Unisinos University, Sao Leopoldo, Brazil (PACA), were studied. Only 29 collections were correctly determined, the rest being placed in other taxa. Since 6 collections were highly weathered, it was impossible to determine them. Thirteen were placed only tentatively becaused they lacked fundamental structures (e.g. spores), or because they differed in some characters from the representative species. Four collections were identified as *H. pratensis* Viégas, so far known only from the holotype. The collections were distributed in 21 taxa. *H. proxima* Rick is regarded as an autonomous species, related to *H. innexa* G.H. Cunn. from which it differs by the absence of paraphyses and smaller setae.

The very few data concerning the genus *Hymenochaete* in the South American continent were mainly the result of the studies of Spegazzini (1880, 1887, 1926), Burt (1918), Viégas (1945) and Rick (1934, 1959). A revision of Father Rick's collections lodged in the Herbarium Anchieta, at Unisinos University, Sao Leopoldo, Brazil (PACA), was carried out, with the aim of contributing with more information in the light of modern criteria.

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[1] Work carried out as part of the research project on xylophilous fungi of Argentina, subsidized by the Argentine National Research Council (CONICET). Publication N°10 of the PRHIDEB.

[2] Fellow of the above Council.

Collections published as:

H. ambiens Berk. & Curt.; Rick, Broteria 30: 36. 1934; Rick Iheringia Bot. 4: 81. 1959.

Brazil, San Salvador, 1943, leg. Rick (PACA 20366) = *H. ANOMALA* Burt (NY!)
Brazil, San Salvador, 1943, leg. Rick (PACA 16405) = *H. PINNATIFIDA* Burt (NY!)
Collection 16405 exhibits the pecularity of having a well bistratified basidiocarp of 300 - 400 um in thickness, which is a character found by Légér (1981) in the collection LY 8091 of Guadalupe.

H. aspera Berk. & Curt.; Rick, Broteria 30: 40. 1934; Rick, Iheringia Bot. 4: 84. 1959.

Brazil, San Salvador, 1943, leg. Rick (PACA 20393). This collections was tentatively determine as *H. minuscula* G.H. Cunn. Although the characters coincide with the description of Cunningham (1963) for such species, the hymenium is in a very bad condition, the spores are very scarce, and their dimension does not coincide with those recorded by Rick on the label.

H. avellana (Fr.) Cke.; Rick, Broteria 30: 39. 1934; Rick, Iheringia Bot. 4: 83. 1959.

Brazil, Sao Leopoldo, 1931, leg. Rick (PACA 16461, 16491) = *H. RIGIDULA* Berk. & Curt. (PC!)
Brazil, San Salvador, 1939, leg. Rick (PACA 16445) = *H. ANOMALA* Burt (NY!)
In this specimen, the incrusted cystidia present are fewer then usual in the species.
Brazil, Sao Leopoldo, 1940, leg. Rick (PACA 19663) = *H. CERVINA* Berk. & Curt.
Brazil, San Salvador, 1943, leg. Rick (PACA 16408). Sterile material, weathered, undeterminable.

H. Boltonni (Sacc.) Cke.; Rick, Iheringia Bot. 4: 84. 1959.

Brazil, Santa María, 1935, leg. Rick (PACA 16441, 16444) = *H. RIGIDULA* Berk. & Curt, (PC!)

H. bonariensis Speg.; Rick, Broteria 30: 38. 1934; Rick, Iheringia Bot. 4: 82. 1959.

Brazil, Sao Leopoldo, 1939, leg. Rick (PACA 16452) = *H. CERVINA* Berk. & Curt.
Brazil, San Salvador, 1943, leg. Rick (PACA 20391) = *H. PINNATIFIDA* Burt (NY!)

H. corrugata (Fr.) Lév.; Rick, Broteria 30: 38. 1934; Rick, Iheringia Bot. 4: 82. 1959.

Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16412). Sterile material, akin to *H. pinnatifida* Burt.

Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16430) = *H. CERVINA* Berk. & Curt.
Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16457). Sterile material, akin to *H. corticolor* Berk. & Rav.
Brazil, Santa María, 1936, leg. Rick (PACA 16472) = *H. RIGIDULA* Berk. & Curt. (PC!)

H. damaecornis (Fr.) Lév.; Rick, Egatea 15: 398. 1931; Rick, Iheringia Bot. 4: 84. 1959.

Brazil, Sao Leopoldo, 1905, leg. Rick (PACA 16409)

H. epichlora (Berk. & Curt.) Cke.; Rick, Broteria 30: 36 1934; Rick, Iheringia Bot. 4: 81. 1959.

Brazil, San Salvador, 1934, leg. Rick (PACA 22848)

H. floridea Berk. & Curt.; Rick, Broteria 30: 38. 1934; Rick Iheringia Bot. 4: 81. 1959.

Brazil, San Salvador, 1945, leg. Rick (PACA 20563) = *H. CERVINA* Berk. & Curt.
Brazil, San Salvador, 1945, leg. Rick (PACA 22817). Sterile material, akin to *H. multisetae* Burt (NY!).

H. fulvella Berk. & Curt.; Rick, Broteria 30: 38. 1934; Rick Iheringia Bot. 4: 83. 1959.

Brazil, Sao Leopoldo, 1931, leg. Rick (PACA 16433) = *H. TABACINA* (Sow.:Fr.) Lév.

The spores of this collection are allantoid and their morphology coincides with those described by Escobar (1978) and Defigio (1970) for the species, differing from Telleria's (1980), who describes *H. tabacina* with oblong elliptical spores.

Brazil, San Salvador, 1945, leg. Rick (PACA 22870) = *H. CORTICOLOR* Berk. & Rav.

H. insularis Berk.; Rick, Broteria 30: 40. 1934; Rick, Iheringia Bot. 4: 83. 1959.

Brazil, Sao Leopoldo, 1931, leg. Rick (PACA 16458) = *H. LEONINA* Berk. & Curt.
Brazil, Parecí, 1935, leg. Rick (PACA 16402)= *H. PINNATIFIDA* Burt (NY!)
Brazil, Sao Leopoldo, 1940, leg. Rick (PACA 16477) = *H. MULTISETAE* Burt (NY!)
Brazil, San Salvador, 1944, leg. Rick (PACA 22714) = *H. ANOMALA* Burt (NY!)

H. olivacea Cke.; Rick, Broteria 30; 37. 1934; Rick, Iheringia Bot. 4: 82. 1959.

Brazil, Sao Leopoldo, 1907, leg. Rick (PACA 16415) = *H. CERVINA* Berk. & Curt.

H. proxima Rick; Broteria 30: 37. 1934; Rick, Iheringia Bot. 4: 82. 1959.

Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16464, holotype). The material is in good condition and its study allowed us to consider *H. proxima* Rick as an autonomous species with the following characteristics: Fructification resupinate, adnate, membranous, even; hymenial surface velutinate "Rose grey" pl. 7 A 8 (Maerz and Paul, 1930), margin thinning out, "Alamo" pl. 14 A 12; 25 - 70 um thick, hyphae intertwined, cemented in zones, which give origin to the hymenium; cortex absent. Setal layer resting on the substrate, composed of 1 or 2 rows of setae regulary distributed with acuminate apices. Setae 40 - 55 x 7 - 10 - (11) um, some incrusted, some of them with the shape of an inverted T, walls naked. Hymenium composed of basidia and basidiola. Basidia subclavate 12 - 16 x 3 - 4 um, 4-spored, sterigmata slender, slightly arquate. Spores cylindrical to slightly suballantoid 5 - 7 x 2 -3 um. *H. proxima* Rick is related to *H. innexa* G.H. Cunn. (PDD!) from which it differs by the absence of paraphyses and smaller setae.

H. sallei Berk. & Curt.; Rick, Egatea 15: 398. 1930; Rick. Iheringia Bot. 4: 84. 1959.

Brazil, Porto Novo, 1935, leg. Rick (PACA 16490); Taquarembó, 1935, leg. Rick (PACA 16473); Santa María, 1935, leg. Rick (PACA 16481)

H. simulans (Berk. & Bres.) Bres.; Rick, Ann. Myc. 9: 178. 1911: Rick, Broteria 30: 39. 1934; Rick, Iheringia Bot. 4: 83. 1959.

Brazil, Sao Leopoldo, 1940, leg. Rick (PACA 16477) = *H. LEONINA* Berk. & Curt.

For this species Defigio (1970) mentions allantoid spores, as they are seen in this collection. Contrary to this, Rattan (1977) mentions ellipsoid spores for the same species.

H. spreta Peck; Rick, Broteria 30: 37. 1934; Rick, Iheringia Bot. 4: 82. 1959

Brazil, Sao Leopoldo, 1932, leg. Rick (PACA 16446, 16480, 16484, 16489) = *H. CORRUGATA* (Fr.) Lév.

Brazil, San Salvador, 1944, leg. Rick (PACA 20930) = *H. MINUSCULA* G.H. Cunn. (PDD!)

Large crystalline masses were found in the trama, and this character was only seen in old specimens of the species (Cunningham, 1963).

H. tabacina (Sow.:Fr.) Lév.; Rick, Egatea 15: 398. 1930; Rick, Iheringia Bot. 4: 83. 1959.

Brazil, Sao Leopoldo, 1906, leg. Rick (PACA 19765) = *H. PINNATIFIDA* Burt (NY!)

Brazil, Sao Leopoldo 1906, leg. Rick (PACA 16475). Sterile material, stratified, undeterminable

H. tenuissima Berk.; Rick. Ann. Myc. 3: 16. 1905; Rick, Iheringia Bot. 4: 84. 1959.

Brazil, Sao Leopoldo, leg. Rick, 1904 (PACA 16410); ibid. 1905 (PACA 16414); ibid. 1930 (PACA 16413); ibid. 1930 (PACA 16510); ibid. (PACA 16442); ibid. 1937 (PACA 16442); San Salvador, leg. Rick, 1943 (PACA 20155) = *H. SALLEI* Berk. & Curt.

H. unicolor Berk. & Curt.; Rick, Broteria 30: 37. 1934; Rick Iheringia Bot. 4: 82. 1959.

Brazil, Parecí, 1935, leg. Rick (PACA 16456) = *H.PINNATIFIDA* Burt (NY!)

Brazil, San Salvador, 1943, leg. Rick (PACA 20327) = akin to *H. unicolor* Berk. This collection presents spores smaller than the normal range for the species (2,8 - 4,5 x 3 - 3,5 um) and a large amount of crystals spread regulary all over the trama; this character is mentioned in the descriptions of *H. unicolor* by Burt (1918), Cunningham (1963) and Escobar (1978).

Unpublished collections:

H. attenuata Lév.

Brazil, Sao Paulo, leg. Rick(PACA 19594) = *H. ATTENUATA* Lév. The characters are those of the species. Since the collection was sterile, the decisive character of size and type of spores could not be observed.

H. cervina Berk. & Curt.

Brazil, Sao Leopoldo, 1936, leg. Rick (PACA 16490).

H. crocata Lév.

Brazil, Santa María, 1935, leg. Rick (PACA 16403, 16463). The characters mentioned by Massee (1889) for this species (type and size of setae, spore shape and dimensions) coincide with those observed in these collections. Taking into account the lack of information about characters of great importance in the modern taxonomy of the genus in the work of Massee, both collections are tentatively kept as *H. crocata.*

H. damaecornis Lév.

Brazil, Sao Paulo, 1895, leg. Rick (PACA 16471).

H. enteroleuca Rick

Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16427) = *H. CERVINA* Berk. & Curt.

Brazil, Sao Leopoldo, 1939, leg. Rick (PACA 16469, 16431) = *H. ANOMALA* Burt (NY!)

Both collections are biestratified. The basidiocarp has a total thickness of 170 - 250 um, each stratum being aproximately 100 um thick. The setae measurements, spore type and range of measurements, type of trama and presence of incrusted cystidia in the hymenium allow no doubt about their determination. So far stratification is a character not mentioned in the literature for this species.

H. epichlora (Berk. & Curt.) Cke.

Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16422) = *H. USTULATA* Escobar (unpublished).
Brazil, Sao Leopoldo, leg. Rick (PACA 16416) = *H. CERVINA* Berk. & Curt.

H. formosa Lév.

Brazil, Sao Leopoldo, leg. Rick 1904 (PACA 16476, 16460); ibid. 1905 (PACA 16468); Sao Paulo, leg. Rick 1931 (PACA 16447); Sao Leopoldo, leg. Rick 1931 (PACA 16419); ibid. 1932 (PACA 16479, 16466); Sao Paulo, leg. Rick 1934 (PACA 16417) = *H. DAMAECORNIS* Lév.

H. imbrincatula (Schw.) Lév.

Brazil, Santa María, 1935, leg. Rick (PACA 16438, 16453) = *H. TABACINA* (Sow.:Fr.) Lév.

Both collections present the characteristic macroscopical features of *H. tabacina* (i.e. hymenial colour, effused reflexed habitat and typical cracked hymenial surface). Neverthless microscopical characters differ in the smaller setae 50 - 70 x 8 - 11 - (16) um, with a relatively wide lumen. Setae in *H. tabacina* have been diversely described by different authors: Burt (1918) and Escobar (1978) give a range 60 - 90 x 6 - 12 um and (35) - 55 - 120 - (145) x (7,5) - 9 - 14 - (16) um respectively, but Cunningham (1963) and Defigio (1970) give different measurements: 80 - 130 x 14 - 22 um and 70 - 130 x 10 - 20 um, respectively. When considering the first authors Rick's collections should be accepted as *H. tabacina* but when considering the latter, Rick's material fit in *H. obesa* G.H. Cunn. (PDD!), which is also characterized by its less crowded setae, appearing in fewer rows. *H. obesa* seems to represent a species related to *H. tabacina*; neverthless its restricted area of distribution (eastern slopes of Mt. Tongari near the Desert Road, Wellington, New Zealand; fide Cunningham, op. cit.), prevents us from making a decision. More material of *H. tabacina* should be studied to clarify its range of variation in function of geographical distribution, so as to establish the validity of both species.

H. kalchbrenneri Massee

Brazil, Sao Leopoldo, 1932, leg. Rick (PACA 16426, 16440, 16450, 16474) = *H. USTULATA* Escobar (unpublished).

H. kunzei (Hooker) Massee

Brazil, Sao Leopoldo, 1932, leg. Rick (PACA 16454, 16487) = *H. LUTEO-BADIA* (Fr.) Hoehn. & Litsch.

H. leonina Berk. & Curt.

Brazil, Sao Leopoldo, leg. Rick (PACA 16455).

H. luteo-badia (Fr.) Hoehn. & Litsch.

Brazil, Sao Leopoldo, leg. Rick (PACA 16455).

H. luteo-roseola Rick

Brazil, Parecí, 1935, leg. Rick (PACA 16470). It is not a species of *Hymenochaete*, but akin to *Peniophora*. The collection is in a very bad condition and the hymenium is practically destroyed, which makes its determination highly difficult. Lamprocystidia and hyphae with clamps were observed, but setae were not.

H. Mougeotii (Fr.) Cke.

Brazil, Sao Leopoldo, 1935, leg. Rick (PACA 16407, 16436) = *H. RIGIDULA* Berk. & Curt. (PC!)
Brazil, Sao Leopoldo, 1935, leg Rick (PACA 16492). Weathered, undeterminable.

H. rhabarbarina (Berk.) Cke.

Brazil, Sao Leopoldo, leg. Rick (PACA 16420, 16451, 16437) = *H. ANOMALA* Burt (NY!)

H. rubiginosa (Dick.:Fr.) Lév.

Brazil, Sao Leopoldo, 1930, leg. Rick (PACA 16432); Santa María, 1935, leg. Rick (PACA 16449).

H. toxia Berk. in Massee

Brazil, Sao Leopoldo, 1939, leg. Rick (PACA 16488) = *H. USTULATA* Escobar (unpublished).

Hymenochaete sp.

Brazil, Sao Leopoldo, 1935, leg. Rick (PACA 16478); San Salvador, 1943, leg. Rick (PACA 19612); ibid., 1944 (PACA 21067, 22918) = *H. PRATENSIS* Viégas (IACM!)
Brazil, Santa María, 1935, leg. Rick (PACA 16486) = *H. CORRUGATA* (Fr.) Lév.
Brazil, Santa María, 1936, leg. Rick (PACA 16439) = *H. USTULATA* Escobar (unpublished).
Brazil, Sao Leopoldo, 1939, leg. Rick (PACA 16425) = *H. CERVINA* Berk. & Curt.
Brazil, Sao Leopoldo, 1939, leg. Rick (PACA 16448); San

Salvador, 1942, leg. Rick (PACA 20396)= *H.RUBIGINOSA* (Fr.) Lév.

Brazil, Sao Leopoldo, 1935, leg. Rick (PACA 16462) = *H. PINNATIFIDA* Burt (NY!)

Brazil, San Salvador, 1943, leg. Rick (PACA 16404); Sao Leopoldo, leg. Rick (PACA 16424). They could not be determined due to the deteriorated condition of their basidiocarps.

Brazil, Parecí, 1942, leg. Rick (PACA 20138) = *STEREUM sp.*

Out of 19 species mentioned by Rick in his papers, only 6 of them: *H. corrugata* (Fr.) Lév., *H. damaecornis* (Fr.) Lév., *H. epichlora* (Berk. & Curt.) Cke., *H. proxima* Rick, *H. sallei* Berk. & Curt. and *H. tabacina* (Sow.:Fr.) Lév. are truly represented in the herbarium; the rest are synonyms of these, or otherwise erroneus determinations. The total amount of species represented in the herbarium is eighteen namely *H. anomala* Burt,*H. cervina* Berk. & Curt.,*H.corticolor* Berk. & Rav.,*H. leonina* Berk. & Curt.,*H. luteo-badia* (Fr.) Hoehn. & Litsch.,*H. minuscula* G.H. Cunn.,*H. multisetae* Burt, *H. pinnatifida* Burt,*H.pratensis* Viégas,*H. rigidula* Berk. & Curt.,*H. rubiginosa* (Fr.) Lév. and *H. ustulata* Escobar, besides those already mentioned. Moreover, four collections were found and these were determined as aff. to *H. attenuata* Lév. *H. crocata* Lév. and *H. unicolor* Berk. & Curt.

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MYCOTAXON

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EAST AFRICAN RUSTS (UREDINALES), MAINLY FROM UGANDA
4. ON FAMILIES BELONGING TO APETALAE AND POLYPETALAE

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SUMMARY

Fifty five rust taxa on host families belonging to the Apetalae and Polypetalae of the Dicotyledones are recorded. Six species are descibed as new, viz. Dietelia impatientis on Impatiens burtonii, Puccinia anthriscicola on Anthriscus sylvestris, P. obscuripora on Rumex abyssinicus, P. peucedani-elgonensis on Peucedanum elgonense, P. peucedani-kerstenii on Peucedanum kerstenii, and Uredo desmodii-ramosissimi on Desmodium ramosissimum. Three species, viz. Puccinia chaerophylli, P. fusispora and P. saniculae are reported as new to the African continent. Seven species are new to Uganda while three and two species are new to Tanzania and Kenya, respectively. New host species are recorded.

As in the previous papers of these studies (Gjærum 1983, 1984, 1984a) the material treated is partly from my own collection made in 1970, and partly from the herbaria in Oslo (O), Uppsala (UPS), Kew (K), Commonwealth Mycological Institute (IMI) and Royal Botanic Garden, Edinburgh (E). For comparison I have borrowed material from Swedish Museum of National History (S), Institut de Botanique Montpellier (MPU), Erbario Tropicale di Firenze (FI) and Plantenziektenkundige Dienst, Wageningen. I want to thank the curators of the said herbaria for lending me material for identification and for comparison.

My sincere thanks are due to Norwegian Agency for International Development (NORAD) which financed a two months stay in 1982 at CMI, including a short visit to the Herbarium of the Royal Botanic Garden, Edinburgh. Later I spent a week in the Herbarium of Royal Botanic Gardens, Kew. I want to thank the directors and staff of these herbaria for kind help.

Mr. K.A. Lye at the Botanical Institute of the Agricultural University of Norway has kindly helped me with host identifications. Dr. G.B. Cummins, Dept. of Plant Pathology, University of Arizona, Tucson, AZ, and Dr. D.M. Henderson, Royal Botanic Garden, Edinburgh, have critically read the manuscript and made valuable suggestions.

Dry material was mounted on double sided tape, coated with gold and observed in a JEOL JSM 840 Scanning Electron Microscop at the EM Laboratory, AGREM, Agricultural University of Norway.

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Aecidium celosiae Jörst., Ark. Bot., Ser. 2, Bd. 3 nr 17: 565, 1956.

On Celosia anthelminthica Aschers. (Amaranthaceae)

Kenya. Eastern Prov., Nyeri Distr., Mt. Kenya, S slope, Regati Forest Station, 2200-2300 m, 02.-03.02.1973, L. Ryvarden (9122,0), I.

No pycnia seen. Aecia hypophyllous, in small groups on brown, necrotic leaf spots. Peridia white, somewhat lacerate. Aeciospores angular or ellipsoid, 18-24 x 15-18 µm, wall c. 1 µm thick, hyaline, delicately verrucose, and with reflecting bodies.

Jörstad (1956a) described this aecial stage on the same host from Mt. Kenya, Meru, the only known locality up to now.

Aecidium ? cookeanum de Toni in Sacc. Sylloge Fung. 7: 822, 1888.

On Loranthus platyphyllus A. Rich. (Loranthaceae)

Teso Distr., Msuki Co., 0.5-1 km E of Mt. Alekilek, 1200 m, 10.05.1970, K.A. Lye & A.B. Katende (5447), I.

Aecia in small groups, hypophyllous. Peridium white. Aeciospores angular or irregular, 18-23(-30) x 16-20 µm, wall 3-4 µm thick, hyaline or slightly coloured, verrucose.

A. cookeanum is widespread in tropical and southern Africa on Loranthus spp., but occurs also on Viscum spp. Wakefield (1920) reported it on Viscum sp. from Kangage Forest, and later Wakefield & Hansford (1949) added Loranthus woodfordioides Schweinf. and L. sp. from Mt. Elgon. L. platyphyllus is a new host for this rust species.

The aeciospore wall is thicker than given in the diagnosis (c. 2 µm). However, Viennot-Bourgin (1958) measured the wall to be 2-2.5 µm thick.

Aecidium englerianum P. Henn. & Lindau, Bull. Herb. Boiss. 1: 110, 1893.

On Clematis hirsuta Perr. & Guill. (Ranunculaceae)

Kigezi Distr., Rubanda Co., Mile 26 on Kabale-Kisoro road, 2100 m, Gj. (214), I.

Tanzania. Mt. Kilimanjaro Reg., Moshi Distr., between Lemosho and Shira Plateau, 2900 m, 12.01.1970, K.A. Lye (M 11), I.

On *Clematis simensis* Fresen.

Kenya. Central Prov., Mt. Kenya, upper Bamboo camp, 01.02.1922, R.E. & Th. C.E. Fries (S), I.

On *Clematis* sp.

Ethiopia. Arussi Prov., Asella, W slope of Mt. Chilalu, 2500-2800 m, 06.01.1973, L. Ryvarden (8659, O), I.

Kenya. Central Prov., Mt. Elgon, S of Suam River valley to Kapchalwa Gate, 2500-3100 m, 24.01.1973, L. Ryvarden (9347, O), I.

The aecia form galls on leaves, petioles and small twigs. Aecia deeply immersed, pustulate, later cupulate. Peridia white, easily broken. Aeciospores angular, ellipsoid, oblong, (18-)22-30 x 13-23 µm, wall 1.5-2 µm thick, verruculose, hyaline.

This rust is widespread from Zaire to Ethiopia and Somalia, and it occurs also in S. Africa. Wakefield & Hansford (1949) reported it on *Clematis* sp. from Mt. Elgon and from the Virunga Mountains. *C. hirsuta* and *C. simensis* are new hosts to the rust in Uganda, but they have been reported from other countries.

Aecidium fluggeae Doidge, Bothalia 2: 210, 1927.

On *Securinega virosa* (Roxb. ex Willd.) Pax & K. Hoffm. (Euphorbiaceae)

Toro Distr., Kyaka Co., Mile 124 on the Kampala-Fort Portal road, 1500 m, Gj. (494), I.

Aecia hypophyllous, in dense groups on thickened spots, up to 6-7 mm in diameter. Peridium white, long, revolute and lacerate. Aeciospores ellipsoid, 20-23 x 15-18 µm, wall 1 µm thick, hyaline or slightly coloured (old spores), verruculose with a few reflecting bodies.

This species is new to the rust flora of Uganda. It was described from S. Africa on *Fluggea microcarpa* Blume (=*F. virosa* (Roxb. ex Willd.) Baill.) and has later been found in Tanzania and Zambia.

Aecidium popowiae P. Henn., Bot. Jb. 34 (1904): 39-57, 1905.

On *Monanthotaxis buchananii* (Engl.) Verdc. (Annonaceae)

Tanzania. Iringa Distr., near Great Ruaha River, 10 km W of Kidatu Bridge, 450 m, 05.09.1970, M. Thulin & B. Mhoro (O), 0 + I.

Pycnia epiphyllous in black spots. Aecia hypophyllous in thickened spots, densely aggregated with yellowish peridia. Aeciospores irregularly oblong to subgloboid 13-20 x 12-15 µm, wall hyaline, 1 µm thick, at apex thickened to 4.5 µm, sometimes also thickened at the base, verrucose.

The aecidial stage was described on *Popowia gracilis* Oliv. (=*Medodorum gracile* (Engl. & Diels) Verdc.) from Dar-es-Salaam. Ebbels & Allen (1979) listed the same specimen.

Aecidium ranunculacearum DC., Fl. Fr. 6: 97, 1815.

On *Ranunculus multifidus* Forsk. (Ranunculaceae)

Bugisu Distr., N. Bugisu Co., at the Forest Reserve Boundary on track to Sasa Hut, c. 2500 m, Gj. (393), 0 + I.

Kenya. Mt. Elgon, E slope, above Tweedie's saw-mill, 2750 m, 22.03.1948, O. Hedberg (107, UPS), and Nyeri, 1800 m, 09.07.1948, O. Hedberg (1486, UPS), 0 + I.
Tanzania. Kilimanjaro, above Marangu, 2750 m, 13.06.1948, O. Hedberg (1154, UPS), 0 + I.

Pycnia amphigenous, between aecia. Aecia in groups, mainly hypophyllous, but also on petioles, cupulate. Aeciospores angular to ellipsoid, 16-23 x (12-)15-20 µm, wall c. 1 µm thick, hyaline, verruculose with reflecting bodies.

A. ranunculacearum has been reported from many countries in Africa, but on the present host from Tanzania only. I find no previous record on this rust from Uganda.

Aecidium torae P. Henn., Bot. Jb. 34: 42, 1904.
Syn. Aecidium cassiae Bres., Rev. mycol. 13: 66, 1891 (non Ae. cassiae Ellis & Kellerm. nom. nud.).
On Cassia obtusifolia L. (Fabaceae)
Teso Distr., Serere Co., Serere Research Station 1150 m, Gj. (452), I; Bugondo, 1050 m, Gj. (455), I.

Aecia mainly hypophyllous in large groups on pale green spots. Peridium white, revolute, short-celled. Aeciospores angular or ellipsoid, 15-20 x 11-15 µm, wall 1 µm thick, verruculose, hyaline, with reflecting bodies.

This aecial stage, widespread in Africa and Asia, was reported by Wakefield & Hansford (1949) on C. tora L. from Lango Distr. C. obtusifolia is a new host for the rust in Uganda, but it has previously been reported by Ebbels & Allen (1979) from Tanzania.

Coleosporium clematidis Barcl., J. Asiat. Soc. Beng. 59, part 2: 89, 1890.
Syn. Caeoma clematidis Thuem., Myc. Ceriv. 539.
On Clematis hirsuta Perr. & Guill. (Ranunculaceae)
Masaka Distr., Bukoto Co., 1-2 km E of Kabayo, 1200 m, 23.04.1972, K.A. Lye (M 116), II; Kigezi Distr., Rubanda Co., Mile 26 on the Kabale-Kisoro road, 2100 m, Gj. (214b), II.
On Clematis simensis Fresen.
Kenya. Near Kapsabet, 17.9.1960, A.C. Tallantire, II.
On Clematis sp.
Kenya. Eastern Prov., Aberdare Mts., Kimakia Forest Station, 2200-2400 m, 16.-18.01.1973, L. Ryvarden (9089, O), II.

Uredinia hypophyllous, irregular, pale yellow. Urediniospores subgloboid, ellipsoid or obovoid, 25-33 x 18-25 µm, wall 1.5 µm thick, hyaline, densely verrucose, pores obscure.

C. clematidis is widespread in Asia from Pakistan to E. Siberia, Japan and Ryukyu Islands, and it is also reported from Australia and Brazil. In Africa it is known in S. Africa, Tanzania, Kenya, Ethiopia and Uganda. C. hirsuta is a new host in Uganda, but it is reported from Kenya and Ethiopia. Other hosts in Uganda are C. inciso-dentata A. Rich. and C. wightiana Wall (Wakefield & Hansford 1949).

Dietelia impatientis n.sp. (Fig. 1)

Pycnia, aecia et uredinia non visa. Telia hypophylla, subepidermalia, erumpentia, dense aggregata, usque ad 1.2 mm in diam, luteola, post germinationes alba. Teliosporae catenulatae, cum cellulis intercalaribus in catenis inferioribus, ellipsoideae, oblongae vel irregulares, 14-37 x 10-17 µm, pariete 1-1.5 µm crasso, laevi, hyalino, poris obscuris.
Holotype: H.B. Gjærum 131 (MHU), Uganda, Ankole Distr., Bunyaruguru Co., Kalinzu Forest, 1400 m, 22.09.1970 on *Impatiens burtonii* Hook. f. (syn. *I. eminii* Warb.) (Balsaminaceae). Isotype in NPPI and PUR.

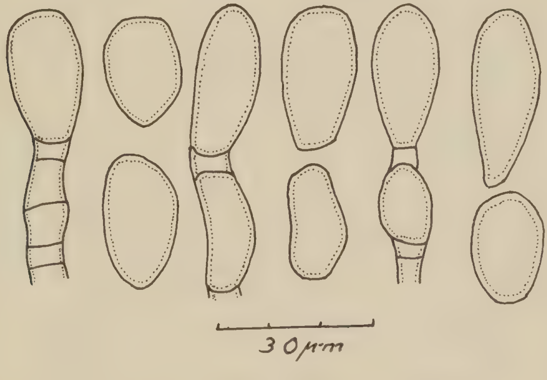

Fig. 1. *Dietelia impatientis*.
Teliospores from type.

Other material:
On *Impatiens meruensis* Gilg. ssp. *cruciata* (T.C.E. Fries) Grey Wilson.
Kigezi Distr., Bufumbira Co., on the saddle between Mt. Muhavura and Gahinga, 3100 m, Gj. (257).

To my knowledge no *Dietelia* has been described on hosts belonging to Balsaminaceae. Previously one *Dietelia* species has been recorded for Africa, viz. *D. codiaei* (H. Syd.) Boerema (syn. *Aecidium codiaei* H. Syd.) on *Codiaeum variegatum* Blume (Euphorbiaceae), known from Nigeria and Ghana. Six other *Dietelia* spp. are known, five of which from the Americas and one from the Philippines and New Guinea.

Hamaspora engleriana (Diet.) P. & H. Syd., Monogr. Ured. 3: 78, 1912.
On *Rubus volkensii* Engl. (Rosaceae)
Bugisu Distr., N. Bugisu Co., Sasa Hut, 3250 m, Gj. (370), II.

Kenya. Eastern Prov., Aberdare Mts., Kimakia Forest Station, 2200-2400 m, 16.-18.01.1973, L. Ryvarden (9088, 0), II; Reg. Mt. Elgon, Kitale Distr., c. 5 km ENE of Koitoboss Peak, 3200 m, 19.01.1969, K.A. Lye (1487), II.
On Rubus sp.
Kenya. Kijabe Escarpment, 10.1949, R.M. Nattrass (IMI 40410), II + III.

Uredinia hypophyllous, round, scattered, yellowish with hairlike paraphyses. Urediniospores subglobose to ellipsoid, 30-36 x 23-28 µm, wall unevenly thick in the spores 3-5(-6) µm, verrucose with scattered pores, covered by hyaline papillae. Telia hypophyllous, caespitose, yellowish, later white. Teliospores 125-152 x 17-23 µm, fusiform, 2-3 septate, wall c. 1 µm thick, hyaline, smooth, apex solid 4-6 µm. Pedicel hyaline, longer than the spore.

According to Monoson (1969) the only Hamaspora species with unevenly thick urediniospore wall and distinct pores is H. engleriana which fits well the specimens listed above.

H. engleriana has previously been reported only from the type locality, viz. Kilimanjaro, Tanzania. Type host is R. volkensii. This rust is new to Uganda, but the IMI 40410 specimen has previously been reported as H. longissima (Thuem.) Koern (Nattrass 1961). Two records from Tanzania by Hennings (1895, 1905) as Phragmidium longissimum Thuem. (= H. longissima) on R. volkensii might be H. engleriana.

Hamaspora longissima (Thuem.) Koern., Hedwigia 16: 23, 1877.
Syn. Phragmidium longissimum Thuem., Flora 58: 379, 1875.
On Rubus friesiorum C.E. Gust. (Rosaceae)
Bugisu Distr., N. Bugisu Co., Sasa Hut, 3250 m, Gj. (374, 378) II + III.
On Rubus cf. steudneri Schweinf.
Ethiopia. Arussi Prov., Asella W slope of Mt. Chilalu, 2500-2800 m, 06.01.1973, L. Ryvarden (8657, 0), II + III.
On Rubus sp.
Ethiopia. Shoa Prov., Wondo Gennet, 1800 m, 27.11.1970, Gj., II + III.

Uredinia hypophyllous, scattered or aggregated, round, yellow, white when dry, with curved hyaline paraphyses. Urediniospores subglobose, obovoid or ellipsoid, 21-29 x 19-23 µm, wall 1.5-2.5(-3) µm thick, hyaline, acutely verrucose, pores obscure. Telia hypophyllous, caespitose, yellowish. Teliospores fusiform, 3(-4) septate, 125-180(-218) µm, wall 1 µm thick, hyaline, the apex solid up to 8(-11) µm.

H. longissima was reported by Wakefield & Hansford (1949) on Rubus spp. from Mubango in Kyagwe, from Kampala, from Butambuli in Mt. Elgon and from Kachwekano in Kigezi. It is widespread in Africa on Rubus spp. and it is also reported from the warmer areas in Asia, but this might be a confusion with H. haskiokai Hirats. f. (cf. Cummins

1950). R. friesiorum and R. steudneri are new hosts for the rust in question.

Melampsora euphorbiae (Schub.) Cast., Obs. 2: 18, 1843.
Syn. M. ricini Pass., Erb. Critt. Ital. ser. 2, fasc. 4. No 684, 1878.
On Euphorbia heterophylla L. (Euphorbiaceae)
W. Mengo Distr., Kyadondo Co., Kampala, Mosque Hill, 1200 m, Gj. (48), II, Makerere, 1200 m, Gj. (11), II, Kasangati 11.11.1970, J. Mukiibi, II, Busiro Co., Kisibawo near Hoima road, Mile 13 from Kampala, 1200 m, Gj. (187), II; Busoga Distr., Bukoli Co., on the road between Jinja and Tororo, 2 km W of River Kibimba, Gj. (414), II, Butembe Bunya Co., Jinja, near Freshwater Fishing Research Station, 1150 m, Gj. (98), II; Bugisu Distr., Central Bugisu Co., 2-3 km N of Busoba, 1200 m, 31.05.1969, K.A. Lye, (3134), II; Teso Distr., Serere Co., Serere Research Station, 1150 m, Gj. (443,445), II; Mubende Distr., Buwekula Co., Mubende Centrum, 1300 m, 26.04.1969, K.A. Lye (3290), II; Singo Co., Kiboga, Gj. (306), II.
On Euphorbia sp.
Bunyoro Distr., Bujenje Co., Budongo Forest 1100 m, 01.05.1962, A.K. Miller, II.
On Ricinus communis L.
Buwekula Co., Mubende Distr., Mubende Hill, 1350 m, Gj. (499), II + III, III very scanty.

Uredinia amphigenous, but mainly hypophyllous, round to oblong, yellow, with capitate, thick-walled, hyaline paraphyses. Urediniospores ellipsoid to globoid, 17-28 x 15-18 µm, wall 1.5(-2) µm thick, hyaline, densely echinulate, pores not visible. Telia amphigenous, subepidermal, crustlike, reddish to dark brown. Teliospores cylindric to prismatic, 27-47 x 6-8 µm, wall 1 µm thick, yellowish-brown, when old darker.

Wakefield & Hansford (1949) reported this world wide distributed rust on E. sp. from Elgon and on R. communis from Kampala and from Katakwi in Teso.

Phakopsora gossypii (Arth.) Hirats. f., Ured. Studies p. 266, 1955.
Syn. Cerotelium gossypii Arth., Bull. Torrey Bot. Club 44: 510, 1917; Phakopsora desmium (Berk. & Br.) Cumm., Ibid. 72: 206, 1945.
On Gossypium sp. cult. (Malvaceae)
W. Mengo Distr., Kyadondo Co., Kasangati, 1200 m, 11.11.1970, J. Mukiibi, II; Teso Distr., Serere Co., Serere Research Station, 1150 m, Gj. (444,454), II; Soroti Co., Arapai Research Station, 1100, Gj. (420), II.

Uredinia amphigenous, round, scattered or in dense groups, surrounded by a brown peridium and with incurved paraphyses, dorsally thickened. Urediniospores obovoid or ellipsoid, 22-33 x 16-22 µm, wall 1-1.5 µm thick, hyaline, echinulate and with 2-3 equatorial pores.

The cotton rust seems to follow the host where this is cultivated. Wakefield (1920) brought the first record from Uganda, and Wakefield & Hansford (1949) found it common on cultivated cotton.

Phakopsora pachyrhizi H. & P. Syd., Annls mycol. 12: 108, 1914.
On _Vigna unguiculata_ (L.) Walp. (Fabaceae)
E. Mengo Distr., Buruli Co., Mile 125 on the Kampala-Masindi road, 1250 m, Gj. (357), II; Bunyoro Distr., Bujenje Co., Itutwe borehole near Biso, 1050 m, Gj. (340), II.

Uredinia in small groups, hypophyllous, with a circular opening. Paraphyses straight or slightly curved, wall less than 1 um thick, at apex thickened up to 5 um, hyaline. Urediniospores ellipsoid, 16-27 x (11-)13-20 um, wall 1 um thick, yellowish to pale brown, echinulate and with scattered, obscure pores.

This rust, reported on _Vigna_ spp. from many African countries, in Nigeria also on _Phaseolus lunatus_ L. (Allen 1979), seems to be new to the flora of Uganda. Outside Africa it is reported from Central and South America, the West Indies, in Asia where it seems to be quite common, and also in Australia and on islands in the Pacific Ocean.

Azbukina (1970) transferred this rust to _Physopella_ as _Ph. pachyrhizi_ (Syd.) Azb., describing the teliospores in chains of 4 to 6 spores. As telia are not present in the specimens studied, I follow Cummins (1978) who described the spores in irregular layers, which also is shown in his drawing.

Physopella hansfordii (Cumm.) Cumm. & Ramachar, Mycologia 50: 742, 1958.
Syn. _Phakopsora hansfordii_ Cumm., Bull. Torrey Bot. Club 70: 523, 1943; _Angiopsora hansfordii_ (Cumm.) Thirum. & Kern (non _A. hansfordii_ Cumm. = _Physopella melinidis_ Cumm.), Mycologia 41: 289, 1949; _Angiopsora hansfordiana_ Jörst., Ark. Bot., Ser. 2, 3: 574, 1956.
On _Acalypha bipartita_ Muell. Arg. (Euphorbiaceae)
E. Mengo Distr., Buruli Co., S of Katugo, 1100 m, Gj. (369), II; Mile 105 on the Masindi road, E of Kafu, 1050 m, Gj. (369), II, W. Mengo Distr., Mawokota Co., Mpanga Forest, 1150 m, Gj. (182), II, Kyadondo Co., 0.5 km E of Port Bell, 1150 m, Lye (1173), II; Mubende Distr., Singo Co., Mile 70 on the Kampala-Hoima road, 1400 m, Gj. (299), II; Bunyoro Distr., Bugahya Co., Hoima, 1500 m, Gj. (333), II.

Uredinia hypophyllous in brown leaf spots, pale brown, as old nearly white, with peripheral, curved paraphyses. Urediniospores ellipsoid to obovoid, 23-32(-37) x 18-22 um, wall 1-1.5 um thick, pale brown, echinulate, with 2-3 equatorial pores, obscure.

This rust was described on _Alchornea cordifolia_ Muell. Arg. from Kawanda in W. Mengo. Later Wakefield & Hansford (1949) reported it on _Acalypha_ sp. from Kigezi. Only uredinia were present in the specimens listed above. Wakefield & Hansford (op.cit.) also listed _Acalypha_ sp. as a host for _Melampsora acalyphae_ Petch, but they mentioned that it might be _Phakopsora hansfordii_ Cumm. The Sydows

(1915) pointed out that the teliospores of *M. acalyphae* described by Petch are paraphyses. They indicated *Ravenelia* as a possible genus.

Ph. hansfordii is also reported from Tanzania and Nigeria.

Puccinia abutili Berk. & Br., J. Linn. Soc. London 14: 91, 1873.
Syn. *P. carbonacea* Kalchbr. & Cooke, Grevillea 9: 24.

On *Abutilon mauritianum* (Jacq.) Medic. (Malvaceae)
W. Mengo Distr., Busiro Co., Bukibero, near Entebbe, 05.09.1970, K.A. Lye (2800); Bunyoro Distr., Bujenje Co., Butiaba, 620 m, Gj. (344); Toro Distr., Busongora Co., Mweya Lodge, 930 m, Gj. (153); III.

On *Wissadula rostrata* (Schum.) Hook. f. (Malvaceae)
Busoga Distr., Bukoli Co., swamp between Butema and Buwuni, 21.1.1969, K.A. Lye (1733); Teso Distr., Serere Co., Serere Research Station, 1150 m, Gj. (447); III.

Telia mostly hypophyllous, brown, pulverulent. Teliospores ellipsoid or ovoid, slightly constricted at septum, 35-49 x 24-27 µm, wall 3-3.5 µm thick, slightly thickened at apex, up to 4-4.5 µm, golden-brown, finely verrucose, upper pore apical, the lower close to the hyaline pedicel which is short or broken just below the spore.

Wakefield & Hansford (1949) reported *P. abutili* on *Abutilon indicum* Sweet, *A. longicuspe* Hochst., *A. mauritianum* and *A.* sp. from several localities scattered over the central and southern part of Uganda, while *W. rostrata* is a new host for the rust in this country.

The rust is widespread on *Abutilon* spp. in Central and South Africa and it is also reported from Mauritius, Sri Lanka and Taiwan, and from India and China. The northermost locality seems to be in Israel (Rayss 1951).

On *Wissadula* it is reported on *W. rostrata* only from Ghana and Sudan and from Guinea on a host plant assumed to be a *Wissadula* species.

Puccinia aframomi Hansf. in Wakefield & Hansford Proc. Linn. Soc. London, Sess. 161, 148-49, Pt. 2: 176, 1949.

On *Aframomum* sp. (Zingiberaceae)
W. Mengo, Mawokota Co., Mpanga CFR, 3 km SW of Mpigi, 1160 m, 09.09.969, K.A. Lye, R.B. Faden & A. Evans, II + III.

Uredinia hypophyllous, yellow-brown. Urediniospores ellipsoid, 23-31 x 13-17 µm, wall 1-1.5 µm thick, hyaline, echinulate and with 2 equatorial pores. Telia hypophyllous, dark brown, compact. Teliospores clavate, slightly constricted at septum, 37-45 x 13-18 µm, wall 1 µm thick, near the apical pore thickened to 1.5 µm, smooth. Pedicel short, hyaline.

P. aframomi was described on *Aframomum* sp. from Uganda where it was reported from the Masaka Road and from Kampala. Later it has been reported on *Aframomum* sp. from Ghana and Ethiopia, and on *A. zambesiacum* K. Schum. from Malawi. It differs from *P. aframomi-gigantei* Yen & Gilles described from Gabon having larger, especially longer urediniospores with a thicker spore wall and with a more yellow colour. According to the descriptions the teliospore sizes are more or less similar in the two species, but the spore wall of *P. aframomi* is nearly hyaline while the other species has brown to pale brown teliospores. Yen & Gilles (1970) indicate that *Uredo longozyi* Bour. & Bass., described from Madagascar, has urediniospores resembling those of *P. aframomi*. From *Uredo aframomi* Har. & Pat. it differs in larger and deeper coloured urediniospores (Wakefield & Hansford 1949).

Puccinia anthriscicola n.sp. (Fig. 2)

Pycnia et aecia non visa. Uredinia hypophylla, ovalia, flava. Urediniosporae ellipsoideae vel obovoideae, 31-40 x 19-26 µm, pariete ab base ad apicem incrassato, apice usque ad 4.5 µm crasso, hyalino, echinulato, sed prope basem laevi, poris obscuris. Telia hypophylla, irregularia, pulverulenta, fusca. Teliosporae ellipsoideae, rotundatae, base et apice rotundato, ad septum leviter constrictae, 36-43 x 28-43 µm, pariete 2-2.5 µm crasso, ad poros leviter incrassato, dense verruculoso, poro superiore ad apicem, poro inferiore prope basem, pedicello hyalino, prope sporam infracto. Holotype: O. Hedberg 974 (UPS), Kenya, Mt. Elgon, N slope of Jackson's Peak, 4215 m, 17.05.1948, on *Anthriscus sylvestris* (L.) Hoffm. (Apiaceae). Isotype in NPPI.

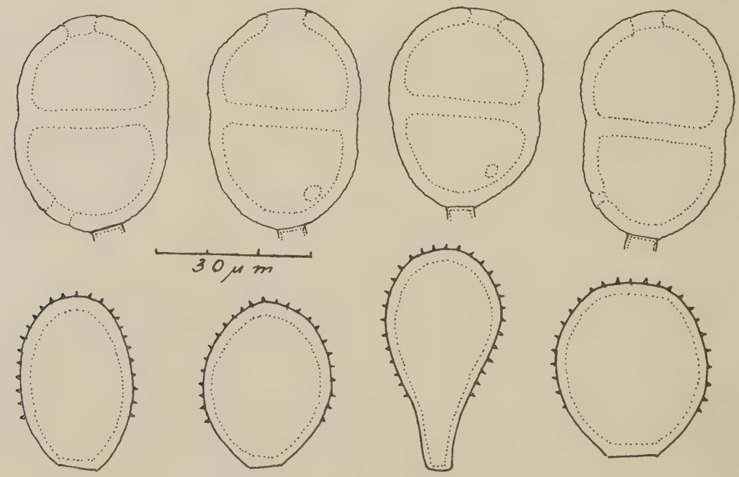

Fig. 2. *Puccinia anthriscicola*.
Uredinio- and teliospores from type.

Other material:
Anthriscus sylvestris (L.) Hoffm.
Uganda. Ruwenzori Mts., Nyabitaba Hut, 8700', 20.07.1966, R.F. Cain, H.D. Griffin & J.C. Krug, TRTC No 66. 1135 (UPS), II + III.

This new rust species differs from *P. chaerophylli* Purt. especially in the form and size of the urediniospores.

Puccinia arenariae (Schum.) Wint., Hedwigia 19: 35, 1880.
Syn. *Uredo arenariae* Schum., Enum. Pl. Saell. 2; 232, 1803 (including III).
On *Cerastium indicum* Wight & Arn. (Caryophyllaceae)
Toro Distr., Burahya Co., Karangora, near Fort Portal, 2100 m, 25.9.56, M.C. (1060), III.
Tanzania. Moshi Distr., Machame, Central Girl's school, 1350 m, 15.02.1955, P. Huxley, III.
On *Spergula arvensis* L. (Caryophyllaceae)
Kigezi Distr., Bufumbira Co., near Kashenyi, 2300 m, 11.12.1968, K.A. Lye & R.N. Lester (Lye 994), III.

Telia hypophyllous on broad leaves, brown to dark brown, compact. Teliospores on *Spergula* clavate to fusiform, rounded or somewhat attenuated at apex, 36-55 x 8-13 µm, the spores on *Cerastium* clavate, upper cell wider (up to 23 µm) than the lower, wall smooth, pale yellowish-brown, 1-1.5 µm thick, at apex thickened up to 9 µm, upper pore apical, lower pore near septum, obscure. Pedicel long, hyaline.

This normally leptosporic rust, known from all parts of the world, has been reported, often under other names, on more than 20 caryophyllaceous host genera. On the African continent it is reported only from Mediterranean countries Morocco, Tunis and Algeria. The rust species is new to Uganda and Tanzania, and *Spergula* seems to be a new host genus in Africa. On *Cerastium* spp. it has been reported from Morocco, but *C. indicum* is a new host in Africa. It is reported as a host for a rust species supposed to be *P. arenariae* from Sri Lanka (Petch 1922).

Puccinia chaerophylli Purt., Bot. Descr. Brit. Pl. III, 1: 303, 1821.
On *Anthriscus sylvestris* (L.) Hoffm. (Apiaceae)
Bugisu Distr., N. Bugiso Co., in bamboo forest above Sasa River, 3000 m, Gj. (381), II(+III); Kigezi Distr., Ruwenzori Mts., Nyabitaba Hut, 2700 m, 20.7.1966, R.F. Cain, H.D. Griffin, J.C. Krug (TRTC 66.1135, IMI 265 928, UPS), II + III.

Uredinia rare, hypophyllous, pale cinnamon-brown. Urediniospores obovoid, echinulate except at the base, 20-23 x 13-21 µm, wall 1.5 µm thick, hyaline, echinulate and with 3 equatorial pores. Teliospores amphigenous, circular or oval, pulverulent, dark brown. Teliospores ellipsoid, not contricted at septum 27-41 x 22-25 µm, wall 1.5-2 µm thick, at apex thickened to 2.5-3 µm, brown, reticulate, upper pore apical, lower deeply depressed. Pedicel deciduous, hyaline.

This rust species, widespread in Europe and Asia, especially on species of *Anthriscus* and *Chaerophyllum*, is a new member of the African rust flora.

Puccinia cyathulicola Cumm., Bull. Torrey Bot. Club 79: 218, 1952.
Syn. *Uromyces cyathulae* P. Henn., Bot. Jb. 17: 10, 1893.
On *Cyathula polycephala* Baker (Amaranthaceae)
Kenya. Eastern Prov., Aberdare Mts., Kimahia Forest Station, 2200-2400 m, 16.-18.01.1973, L. Ryvarden (9087), II, Nyere Distr., Mt. Kenya, S slope, Regati Forest Station, 02.-03.02.1973, L. Ryvarden (9115), II.
On *Cyathula uncinulata* (Schrad.) Schinz. (Amaranthaceae)
Sebei Distr., Sebei Co., near Kapkwata Forest Station, 2100 m, 20.01.1969, K.A. Lye (1623), II; Ankole Distr., Bunyaruguru Co., Kalinzu Forest, 1400 m, Gj. (133,138), II; Kigezi Distr., Rubanda Co., Nyamabale, 2100 m, Gj. (222), II, Bufumbira Co,., Nkanda, 2300 m, Gj. (240), II.

Uredinia hypophyllous, irregularly formed, dark brown. Urediniospores ellipsoid to subgloboid, 37-50 x 27-35 µm, wall (2.5-)3-3.5(4.5) µm thick, brown, at apex some spores are thickened up to 10 µm, echinulate and with 2 equatorial pores.

Cummins (op.cit.) described two varieties of this rust species, viz. var. *cyathulicola* and var. *keniensis*, the latter differing from the type having urediniospores thickened at apex. Laundon (1965) found that the urediniospores showed a complete gradation from one type to the other. In the present material the two specimens of *C. polycephala* have urediniospores corresponding to those described for var. *keniensis*. In the specimens of *C. uncinulata* some spores have an evenly thick wall while others are distinctly thickened at apex (up to 6 µm).

Other rust species on *Cyathula* are *Puccinia padwichii* Cumm. and *Uredo cyathulae* Mayor, the former described from India, the latter from Colombia. Both have smaller urediniospores than has *P. cyathulicola*.

Wakefield (1920) reported *Uromyces cyathulae* Henn. on *C. globulifera* Moquin (= *C. uncinulata*) from Kipayo in Kyagwe while Wakefield & Hansford (1949) listed the same specimen under *Uredo gomphrenae* Barcl. together with another from Kigezi and one on *C. polycephala* Baker from Sebei. Laundon (1965) has the same specimens placed with *P. cyathulicola*.

Puccinia exilis P. & H. Syd., Monogr. Ured. I: 481, 1903, var. hibisci Grove, Kew Bull. 10: 270, 1916.
On *Hibiscus calophyllus* Cav. (Malvaceae)
W. Mengo Distr., Mawokota Co., Mpanga Forest, 1150 m, Gj. (181), III.
On *Hibiscus* cf. *canescens* Hayn.
Kenya. Eastern Prov., Nyeri Distr., Mt. Kenya, S slope, Regati Forest Station, 2200-2300 m, 02.-03.01.1973, L. Ryvarden (9113, 0), III.

Telia round, confluent, pulvinate, cinnamon-brown.

Teliospores ellipsoid, obovoid or obclavate, slightly constricted at septum, 32-41 x 14-17 µm, wall 1.5 µm thick, slightly thickened at apex, smooth, hyaline. Pedicel long, hyaline, persistent.

This variety of *P. exilis*, described on *Hibiscus* sp. from Kirerema in Kyagwe has also been reported on *H. rostellatus* Guill. & Perr. and *H.* sp. from the Kampala area (Wakefield & Hansford 1949). *H. calophyllus* is a new host for the rust in Uganda, but it has been found with the rust in Kenya. From Kenya Nattrass (1961) recorded *Kosteletzkya adoensis* (A. Rich.) Mast. as a host for *P. exilis*. On *H. furcatus* it has been reported from Ghana. *H. canescens* is a new host for the rust.

The other variety, var. *exilis*, is known on *Pavonia rosea* Schlecht. and *P. leucantha* from the Central and South Americas.

Puccinia fusispora P. & H. Syd., Monogr. Ured. 1: 590, 1903. (Fig. 3).
On *Droguetia iners* (Forsk.) Schweinf. (Urticaceae)
Kigesi Distr., Mafuga Central Forest Reserve, 23.12.1961. M.E.S. Morrison, III.
On *Pilea* aff. *ceratomera* Wedd. (Urticaceae)
Kenya. Central Prov., Mt. Elgon, Suam Forest Station, c. 2100 m, 23-24.01.1973, L. Ryvarden (9269, O), III.

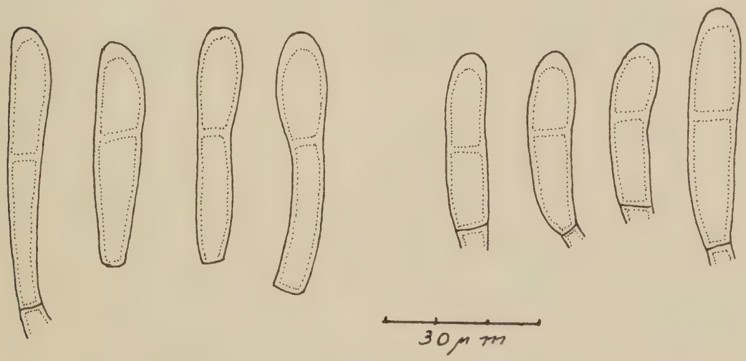

Fig. 3. *Puccinia fusispora*
Teliospores from a. *Pilea* aff. *ceratomera*,
b. *Droguetia iners*.

Telia hypophyllous, sori pulvinate, in small, dense groups, arranged in a ring around a central sorus which sometimes is lacking, cinnamon, later white. Teliospores fusiform or clavate, then rounded or somewhat truncate at apex, 31-55 x 8.5-10 µm, wall hyaline, 0.5-1 µm thick, at apex thickened to 4 µm, in ungerminated spores pores not visible, pedicel short, hyaline.

Both hosts are new to this rust species, and to my knowledge no rust has previously been mentioned on Droguetia. P. fusispora, which is a new rust species to Africa, was described on Urtica angustifolia Fisch. from Manchuria, later reported from Far East Siberia and Japan on Urtica spp. and also from China on Boehmeria. Jørstad (1959) pointed out that P. fusispora is closely allied to P. urticae Barcl., known on Urtica spp. from India, Pakistan and Ecuador. However, Sydow & Mitter (1935) discussed the two species and kept them separate, basing their decision on the width of the spores and the shape of the sori.

Puccinia garckiana March. & Steyart, Bull. Soc. r. Bot. Belg. 61: 164, 1929.
Syn. Aecidium garckeanum P. Henn., Bot. Jb. 14: 372, 1891.
On Hibiscus cannabinus L. (Malvaceae)
Teso Distr., Soroti Co., Arapai Research Station,1100 m, Gj. (420 a), I.

Aecia hypophyllous in small groups. Peridium white, short. Aeciospores ovoid, angular, 15-18 x 12-17 µm, wall 1 µm thick, verruculose, hyaline.

This aecial stage is widespread in Africa, occurring on many Hibiscus spp. It was reported from Uganda by Wakefield & Hansford (1949) from Katini in Teso and on H. cannabinus and H. sp. from Mugomba in Kyagwe. Aecidium hibisci-surrattensis Mayor & Viennot-Bourgin from Côte-d'Ivoire is said to have similar aecia, but acc. to the diagnosis it has smaller spores. A. erythrobasis Berk. & Br. from Sri Lanka has larger spores. Telia was described from Zaire.

Puccinia heterospora Berk. & Curt., J. Linn. Soc. London 10: 356, 1868.
On Sida alba L. (Malvaceae)
Teso, Soroti Co., Arapai Research Station, 1100 m, Gj. (415); Serere Co., Serere Research Station, 1150 m, Gj. (448).
On S. rhombifolia L. (Malvaceae)
Mubende, Singo Co., Hoima road, Mile 101, 1400 m, 16.10.1970, Gj. (318).
On S. urens L. (Malvaceae)
W. Mengo, Kyadondo Co., Kampala, Makerere Hill, 1200 m, 17.01.1961, A.C. Tallantire; 05.08.1961, F.K. Kasube; Gj. (37); E. Mengo, Buruli Co., Mile 125 on the Kampala-Masindi road, 1250 m, Gj. (361); Busoga, Butembe Bunya Co., Jinja, near Fresh Water Station, 1150 m, Gj. (107); Bunyoro, Bujenje Co., Budongo Forest, near Biso sawmill, 1050 m, Gj. (349).

Telia hypophyllous in yellow-brown leaf spots, dark brown, compact, in dense groups. Teliospores one- or two-celled, wall brown, smooth, one-celled spores 20-30(-35) µm, 1.5-2 µm thick, at apex thickened to 8.5 µm, pore apical, two-celled spores 19-27 x 16-25 µm, wall 1.5-2 µm thick, thickened to 4 µm at apex, pores obscure, pedicel oblique or for two-celled spores often transversally attached, hyaline.

P. heterospora is reported from several countries in tropical and southern Africa, mainly on Sida spp., but also on species of Abutilon and Hibiscus. Outside Africa it is reported from Asia, Australia and the Americas. From Uganda Wakefield & Hansford (1949) reported it on Abutilon sp. and Sida rhombifolia from Kipayo and Namilyango in Kyagwe resp., on Sida grewioides Guill. & Perr. from Mbarara in Ankole, S. sp. from Entebbe in W. Mengo and on S. urens without giving the locality. Sida alba is a new host for this rust in Uganda, but has been reported as a host from Ghana, Sudan and Zambia.

The greater number of spores in the specimens examined were one-celled.

Puccinia keniensis Jørst., Ark. Bot., Ser. 2, Bd. 3 Nr. 17: 578, 1956.

On Hypericum revolutum Vahl (Hypericaceae)

Bugisu Distr., N. Bugisu Co., near Sasa River on track to Sasa Hut, 2900 m, Gj. (383), III; Kigezi Distr., Bufumbira Co., in Forest Reserve on track to Gahinga, 2600 m, Gj. (250), III.

Tanzania. Moshi Distr., Mt. Kilimanjaro, between Lemosho and Shira Plateau, 2900 m, 12.1.1970, K.A. Lye (M12), II + III.

On Hypericum roeperanum A. Rich.

Bugisu Distr., N. Bugisu Co., above Forest Reserve Boundary on track to Sasa Hut, c. 2800 m, Gj. (390), II, Karamoja Distr., Mathenico Co., Mt. Moroto, 2400 m, 29.12.1957, S.F. Beadle, II + III.

On Hypericum sp.

Ruwenzori, S slope of Mt. Baker, 4150 m, 10.04.1948, O. Hedberg (738, UPS), II.

Uredinia amphigenous, yellowish, irregular. Urediniospores obovoid or ellipsoid, 25-35 x 13-20 µm, wall 1.5-2.5 µm thick, echinulate, pores scattered, obscure, pedicel longer than the spore, hyaline. Telia hypophyllous, round, oval or elliptic, surrounded by epidermis, compact, pale yellow. Teliospores fusiform, ellipsoid or clavate, slightly constricted at septum, 55-70 x 23-30 µm, wall 1.5-2.5 µm thick, hyaline, smooth. Pedicel persistent. In some sori in specimen M 12 teliospores were up to 35 µm wide.

P. keniensis was described without uredinia from Mt. Kenya on H. quartinianum A. Rich. In the specimen where both uredinia and telia are present, teliospores occur also in the uredinia.

The rust is new to Uganda and H. roeperanum is a new host for the rust. H. revolutum is a new host for the rust in Tanzania, reported on H. lanceolatum Lam. by Henderson (1972).

Puccinia leptosperma P. & H. Syd., Monogr. Ured. 1: 557, 1903.

On Drymaria cordata (L.) (Willd. ex) Roem. & Sch.

(Caryophyllaceae)
W. Mengo Distr., Busiro Co., Entebbe, Botanic Garden, 1150 m, Gj. (9), III.
Kenya. Eastern Prov., Meru Distr., Mt. Kenya, NE slope, Chigora track, 1900-2200 m, 31.01.-01.02.1973, L. Ryvarden (9760 ,0), III.

Telia hypophyllous, irregular, confluent, compact, cinnamon-brown. Teliospores fusiform, slightly constricted at the septum, 32-47 x 10-13 µm, wall 1 µm thick, at apex thickened to 4 µm, smooth, pores obscure, hyaline. Pedicel hyaline, persistent.

P. leptosperma was reported from Kivuvu in Kyagwe by Wakefield (1920) and from Entebbe in W. Mengo by Wakefield & Hansford (1949). *D. cordata* is the only host for this rust which is new to Kenya, but known from Ethiopia, Zaire, Cameroon, S. Africa and Madagascar.

Puccinia leveillei Mont., in Gay, Hist. Fis. Polit. Chile 8: 41, 1852.
Syn. *P. geranii-silvatici* Karst., Notis. Sällsk. Fauna Fl. Fenn. 8: 220, 1866.
On *Geranium aculeolatum* Oliv. (Geraniaceae)
Bugisu Distr., N. Bugisu Co., Forest Research Boundary, on track to Sasa Hut, c. 2500 m, Gj. (392), III.
Tanzania. Kilimanjaro, above Marangu, near Bismarck Hut, 2750 m, 13.06.1948, O. Hedberg (1155, UPS), III.
On *Geranium arabicum* Forsk. ssp. *arabicum* (syn. *G. simense* A. Rich.).
Kenya. Central Prov., Mt. Elgon, Suam Forest Station, 2100 m, 23.-24.01.1973, L. Ryvarden (9262a, O), III.

Telia hypophyllous, irregular, brown, pulverulent. Teliospores ellipsoid or obovoid, slightly or not constricted at septum, 23-39 x 16-23 µm, wall 2.5-3 µm thick, sometimes slightly thicker at apex, verrucose at the upper cell, at the lower cell with smaller warts and nearly smooth towards the hyaline pedicel. Upper pore apical, the lower much depressed, sometimes close to the pedicel, covered with low hyaline papillae. One- and three-celled spores very rare.

Wakefield & Hansford (1949) reported this microform on *Geranium* sp. from Nhokonjeru in Busigu and Kyasoweri, Elgon. Both hosts mentioned are new hosts in Uganda, but the first one is reported from Kenya and Malawi, the second from Tanzania only. *P. leveillei*, widespread in Europe, Asia and the Americas, is normally found in the subalpine areas.

Puccinia obscuripora n.sp. (Fig. 4)

Pycnia et aecia non visa. Uredinia amphigena, dispersa, rotunda vel oblonga, epiderme tam diu obtecta, massa sporarum hyalina vel demum leviter flavida. Urediniosporae obovoideae vel ellipsoideae, interdum unilaterale complanatae, 25-30 x 15-23 µm, pariete minus quam 1 µm crasso, echinulato, 2(-3?) poris obscuris equatorialibus instructis. Telia amphigena, statura variabilissima, irregularia, epiderme tam diu obtecta,

fusca, compacta. Teliosporae obclavatae, ad septum leviter constrictae, ad apicem rotundatae vel attenuatae, 32-51 x (13-)15-21 µm, cellula inferior longior quam superior, pariete 1-1.5 µm crasso ad apicem usque 7 µm incrassato, cinnamomeo, laevi, poro superiore apicali, poro inferiore obscuro, pedicello hyalino, pariete tenui, usque 15 µm longo, persistenti.
Holotype: S.A.S. Tarr 2487 (IMI 59067), 19.11.1954, Sudan, Gilo, on Rumex abyssinicus Jacq. (Polygonaceae).

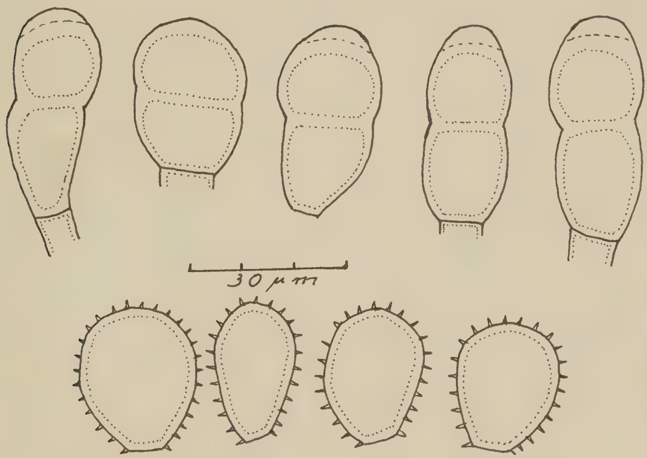

Fig. 4. Puccinia obscuripora.
Telio- and urediniospores from type.

Other material:
On Rumex abyssinicus Jacq.
Kigezi Distr., Rubanda Co., Echuya Forest Reserve, Mile 33 and Mile 34-35 on the Kabale-Kisoro road, 2100 m, Gj. (231,238), II.
On Rumex bequartii De Wild.
Bugisu Distr., N. Bugisu Co., Sasa Hut, 3250 m, Gj. (379), II; Kigezi Distr., Kinkizi Co., Bwindi Forest Reserve, lower border, Gj. (224), II.
Kenya. Eastern Prov., Nyeri Distr., Mt. Kenya S slope, Regati Forest Station, 2200-2300 m, 02.-03.02.1973, L. Ryvarden (9805), II.
On Rumex nepalensis Spreng.
Ethiopia. Jecama campus, 10.1960, R.B. Stewart (IMI 88515), II.
On Rumex ruwensoriensis Chiov.
Kenya. Eastern Prov., Nyeri Distr., Mt. Kenya S slope, Regati Forest Station, 02.-03.-02.-1973, L. Ryvarden

(9803, 0), II.
On Rumex steudelii Hochst. ex A. Rich.
Ethiopia. Holetta, 16.11.1971, E. Niemann (1562, IMI 215700), II.
On Rumex usambarensis (Dammer) Dammer.
Kigezi Distr., Rubanda Co., Mile 26 on Kabale-Kisoro road, Gj., (212), II.
On Rumex sp.
Ethiopia. Dabre Brehan, 26.09.1964, D. Yirgou (65, IMI 116502), II.

This rust species differs from other species on Rumex by its hyaline, thin-walled urediniospores.

The IMI 116502 was published by Stewart & Yirgou (1967) as P. ludwigii Tepp, but the identification was not accepted at CMI and kept as Puccinia sp. The IMI 88515 was published by Stewart & Yirgou (op. cit.) as Puccinia sp.

Puccinia pelargonii-zonalis Doidge, Bothalia 2: 98, 1926.
On Pelargonium zonale Hort. (cult.) (Geraniaceae)
W. Mengo Distr., Kampala, Makerere Hill, 1200 m, Gj. (1), II + III, and Nakasero, Gj. (67), II; Busoga Distr., Butembe Bunya Co., Jinja, Rippon Falls Hotel, 1150 m, II, Gj. (96); Ankole Distr., Kashari Co., Mbarara, Agip Hotel, 1200 m, II + III Gj. (116).

Uredinia mainly hypophyllous, rarely epiphyllous, often in rings around the primary sorus, brown. Urediniospores ellipsoid to globoid, 23-30 x 19-24 µm, wall 1-1.5 µm thick, yellow-brown, echinulate, with 2 equatorial or slightly superequatorial distinct pores. Telia between the uredinia, darker brown than the uredinia, small, long covered by epidermis, or teliospores mixed within the uredinia. Teliospores clavate, rounded or somewhat truncate or attenuated at apex, 40-55 x 20-26 µm, wall 1-1.5(-2) µm thick, at apex thickened up to 5.5 µm, pale brown, upper cell wall darker than the lower. Pedicel hyaline.

The pelargonium rust, originally described on P. zonale from S. Africa and widespread in Africa, is now common in Europe where it does serious damage to the cultivated host. It is also reported from Australia and the Americas. In S. Africa it has been found on P. inquinans Ait.

P. granularis Kalchbr. & Cooke, known from Kenya and S. Africa on Pelargonium spp., has uredinio- and teliospores with thicker walls.

Puccinia peucedani-elgonensis n.sp. (Fig. 5)

Pycnia amphigena et in petiolis pallide lutea, typus 4. Aecia aggregata in maculi foliorum et petiolis aurantiacis et incrassatis, cupulata, ca 450 µm diam., peridio albo, brevi, lacerato. Cellulae peridii rhomboideae vel rectangulatae, 27-43 x 16-22 µm, pariete externo laevi, 4 µm crasso, pariete interno 4 µm crasso, dense verrucoso, verrucis 3-4 µm longis. Aeciosporae globoideae, ellipsoideae vel angularae, 23-31 x 16-22 µm, pariete ca 1 µm crasso, hyalino, dense verruculoso, prope basem laevi. Uredinia non visa, sed urediniosporae in

teliis immixtis. Urediniosporae obovoideae vel subgloboideae, 25-35 x 25-31 µm, pariete 1.5-2 µm crasso, hyalino, dense echinulato, poris obscuris. Telia amphigena, rotundata, castanea. Teliosporae ellipsoideae vel obovoideae, ad septum leviter constrictae, 38-45 x 28-38 µm, pariete 2-2.5 µm crasso, brunneo, verruculoso, poro superiore apicali, poro inferiore prope pedicellum instructis, uterque papilla complanata obtecta, pedicello hyalino, brevi.

Holotype: L. Ryvarden 9263 (O), 24.01.1973, Kenya, Central Prov., Mt. Elgon, S of Suam River valley to Kapchalwa Gate, 2500-3100 m, on Peucedanum elgonense Wolff (Apiaceae). Isotype in NPPI.

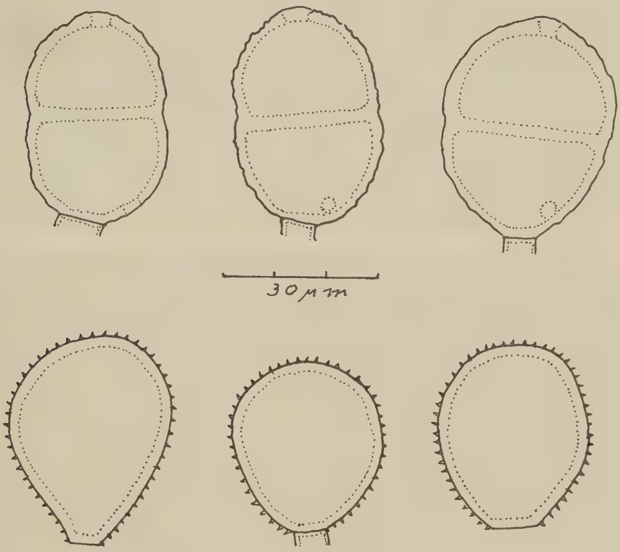

Fig. 5. Puccinia peucedani-elgonensis
Telio- and urediniospores from type.

Other material:
On Peucedanum elgonense Wolff
Bugisu Distr., N. Bugisu Co., Sasa Hut, 3250 m, Gj. (371) I + II + III, Mt. Elgon, below Jackson's Summit, 4100 m, Gj. (411), 0+I(+II) + III.
Kenya. Central Prov., Mt. Elgon, S of Suam River Valley to Kapchalva Gate, 2500-3100 m, 24.01.1973, L. Ryvarden

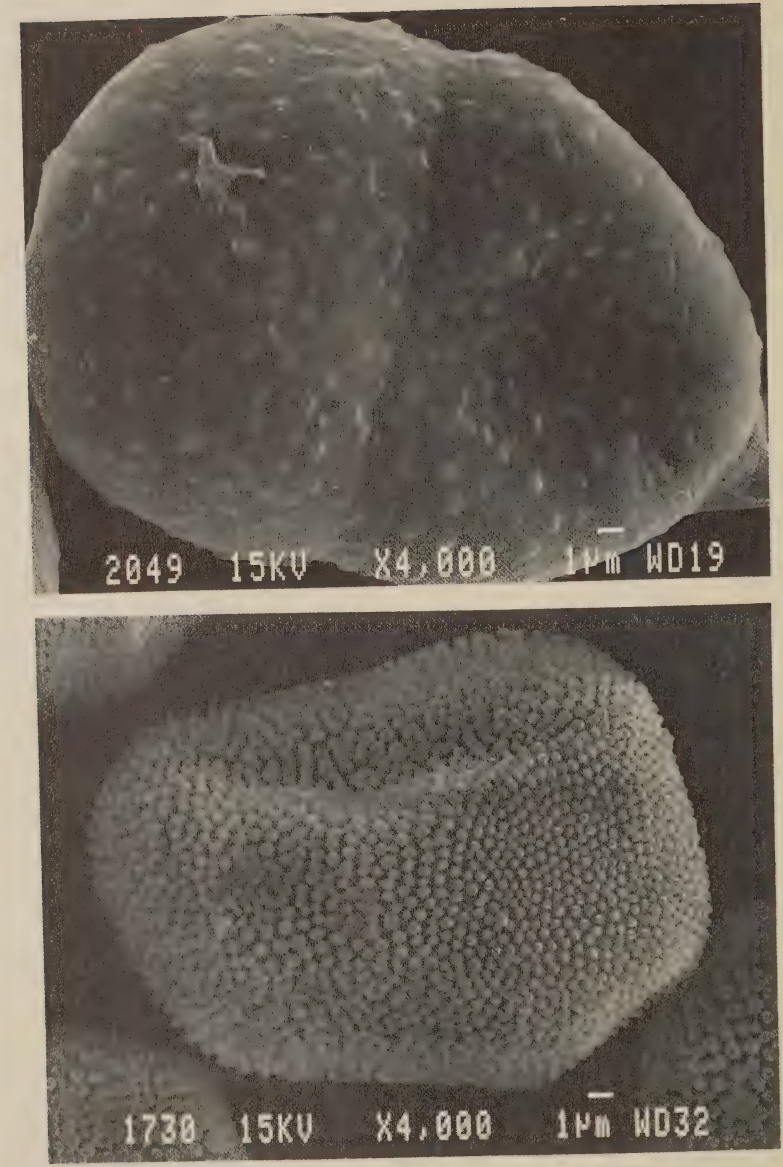
2049 15KV X4,000 1µm WD19
1730 15KV X4,000 1µm WD32

Fig. 6. *Puccinia peucedani-elgonensis*. Teliospore (above) and aeciospore (below) from type.

(9263, O), 0+I+II+III.
On Peucedanum linderi Norman
Kigezi Distr., Bufumbira Co., on track to Gahinga 3100 m, Gj. (246), 0 + I + III.
On Peucedanum runssoricum Engl.
Toro Distr., Ruwenzori, Bujuku Valley, near Bigo camp, 3400 m, 02.04.1948, O. Hedberg (651, UPS), I, near Nyamileju Hut, 30.12.1968, K.A. Lye (1264), 0 + I; Bukuju Hut, 13100', 25.07.1966, Cain, Griffin & Krug (66.1162, E), I+III.

Puccinia peucedani-kerstenii n. sp. (Fig. 7)

Pycnia hypophylla, pallide lutea, typus 4. Aecia aggregata in maculis foliorum aurantiacis et incrassatis, cupulata, ca 400-500 μm diam., peridio albo, brevi, lacerato. Cellulae peridii rhomboideae vel rectangulatae, 27-35 x 16-20 μm, pariete externo laevi, 4 μm crasso, pariete interno 4 um crasso, dense verrucoso, verrucis ca 3 μm longis. Aeciosporae globoideae, ellipsoideae vel ovoideae, 27-35 x 21-27 μm, pariete ca 1 μm crasso, hyalino, dense verruculoso, prope basem laevi. Uredinia non visa, sed urediniosporae in teliis immixtis. Urediniosporae globoideae vel subgloboideae, 37-42 x 25-31 μm,

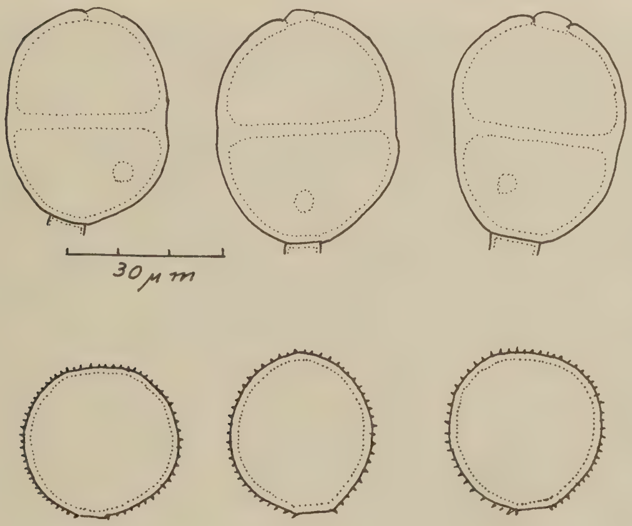

Fig. 7. Puccinia peucedani-kerstenii
Teliospore (above) and aecidiospore (below) from type.

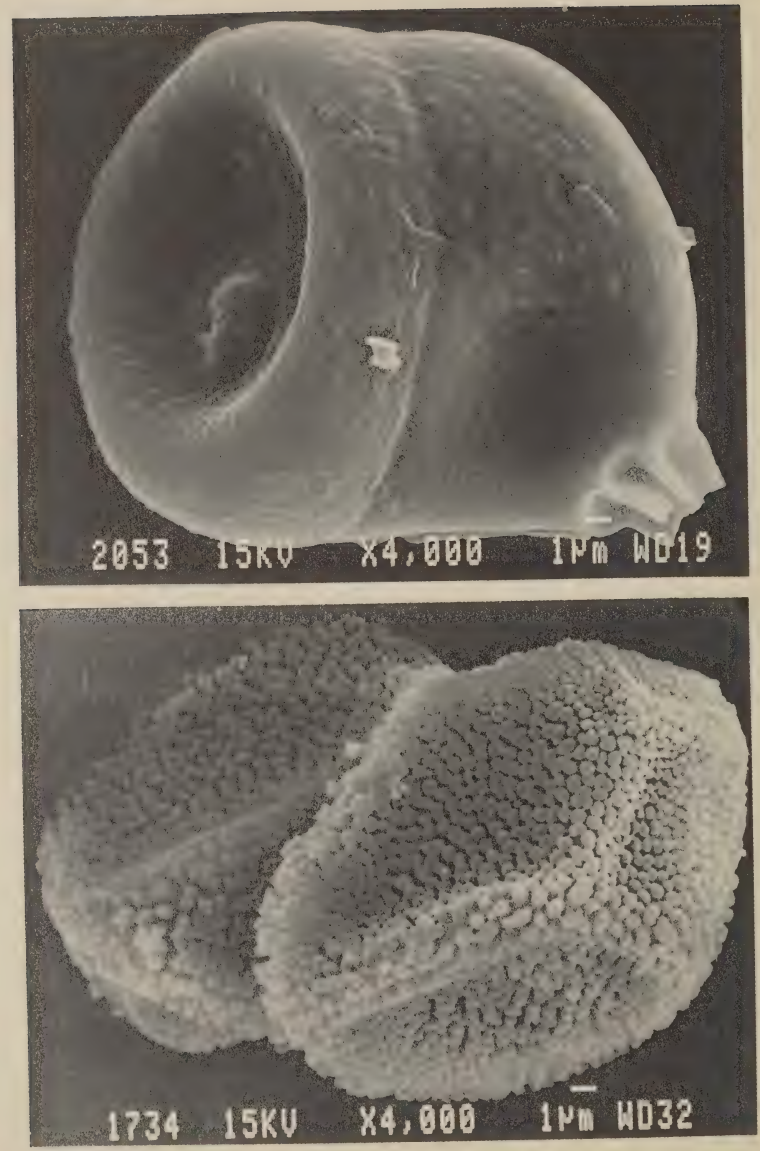
2053 15KV X4,000 1µm WD19
1734 15KV X4,000 1µm WD32

Fig. 8. Puccinia peucedani-kerstenii. Teliospore (above) and aeciospore (below), from type.

pariete 1-1.5 µm crasso, hyalino, echinulato, poris obscuris. Telia amphigena, rotundata vel oblonga, castanea. Teliosporae ellipsoideae vel leviter obovoideae, raro ovoideae, ad septum leviter constrictae, 28-34 x 22-26 µm, pariete 1.5 µm crasso, brunneo, laeve vel aliquot verrucis, poro superiore apicali, poro inferiore prope pedicellum instructis, uterque papilla complanata obtecta, pedicello hyalino, brevi.
Holotype: H.B. Gjærum 260 (MHU), 02.10.1970, Uganda, Kigezi Distr., Bufumbira Co., just below the summit of Gahinga, 3400 m, on Peucedanum kerstenii Engl. (Apiaceae). Isotype in NPPI.

Other material:
On Peucedanum kerstenii Engl.
Bugisu Distr., N. Bugisu Co., Sasa Hut, 3250 m, Gj. (380), 0+I+III, 16.06.1970, K.A. Lye (M20), 0+I+III, Mt. Elgon, below Jackson's Summit, 4000 m, Gj. (413), 0+I+III; Mt. Elgon, in the crater, 3900 m, 20.05.1948, O. Hedberg (1009, UPS), 0+I; Ruwenzori Mts., Nyabitaba Hut, 8700', 20.07.1966 (TRTC No 66.1135, S, E), and Lower Bigo Bog, Bigo Hut, 11300', 21.07.1966, R.F. Cain, H.D. Griffin & J.C. Krug (TRTC No 66.1151, S, E), I+III, Bujuku Valley, near Bigo Camp, 3450 m, 22.03.1948, O. Hedberg (394, UPS), 0+I+III, Mt. Ruwensori 12500', 08.1938, J.W. Purseglove (273, K), I+III.

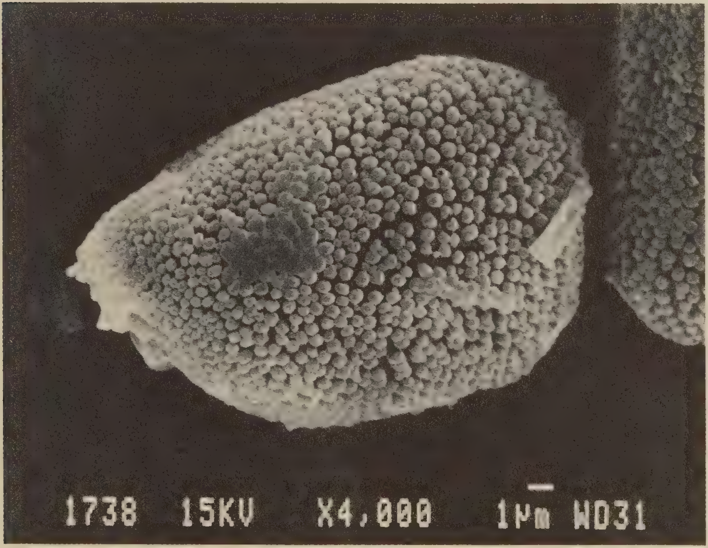

Fig. 9. Aecidium peucedani-raiblensis.
Aeciospore from type.

Kenya. Mt. Kenya, NW slope, 3420 m, 20.08.1948, O. Hedberg (1993, UPS), 0+I+III; Aberdare Ranger, Kinangop, N slope, 3600 m, 17.07.1948, O. Hedberg (1616, UPS), 0+I.
Tanzania. Kilimanjaro, above Marangu, 3700 m, 20.06.1948, O. Hedberg (1316, UPS), 0+I.

Wakefield & Hansford (1949) placed the aecial stage on Peucedanum kerstenii with the Austrian Aecidium peucedani-raiblensis Maire, described from Tyrol, finding that the spore size corresponded fairly well. Moreau (1950) referring to Wakefield & Hansford mentioned that the aecial stage on Pe. kerstenii was near A. peucedani Bacc., known from Ethiopia. Jørstad (1956) placed the aecial stage on Pe. petitianum A. Rich. from Rwanda in A. cf. peucedani-raiblensis, also referring to Wakefield & Hansford's description, but indicated that A. peucedani might be the same. Henderson (1970) also placed an aecial stage on Pe. runssoricum and Pe. kerstenii, both from Uganda, within the same species and referring to Jørstad, but mentioned that "until more stages of the life cycle are discovered the correct name must remain in some doubt". A study of the type specimen of A. peucedani (FI) showed that the aeciospores are verrucose and easily separated from the other aecial stages mentioned on Peucedanum.

When comparing the aecial stages on the Peucedanum spp. listed under the two rust species Pu. peucedani-elgonensis and Pu. peucedani-kerstenii with the type of A. peucedani-raiblensis (MPU, Fig. 9) I found that the latter have yellowish aeciospores while in the two other species they are hyaline. As the aecia on the two African species often are followed by telia, even located between the aecia, I do feel certain that they belong to the telia.

The aecial stage of Pu. peucedani-kerstenii on the finely divided, linear-leaved Pe. kerstenii might be difficult to separate from that of Pu. peucedani-elgonense on the broad-leaved Pe. elgonense, Pe. linderi and Pe. runssoricum. However, they are easily separated when telia are present as the former has teliospores nearly smooth, only with very low warts occur (Fig. 8) while in the latter the spores are evenly verruculose (Fig. 6). This is also seen in a light microscope with a magnification of 600-700 times.

As Pe. petitianum also belongs to the broad-leaved group of Peucedanum, the aecial stage might belong to Pe. peucedani-elgonense, but as no telia are present, nothing can be said with certainty.

The only Puccinia sp. known on Peucedanum in Africa is Pu. munbyi Gaeum. described from Algeria on Pe. munbyi Boiss. Its teliospores, the only spore stage known, are much longer than are those of the two species described here.

Puccinia polygoni-amphibii Pers., Syn. Meth. Fung. p. 227, 1801.
Syn. Aecidium sanguinolentum Lindr., Bot. Notiser: 241, 1900.

On Oxygonum sinuatum (Meisn.) Dammer (Polygonaceae)
Kenya. Eastern Prov., Meru Distr., Mt. Kenya, NE slope, Chigora track, 1900-2200 m, 31.01.-01.02.1973, L. Ryvarden (9762, O), II.
Tanzania. Bukoba-Kiziba, 1250 m, 28.06.1963, F. Nyahega (23), II.
On Polygonum setosulum A. Rich.
Bugisu distr., N. Bugisu Co., Bumasifwa School, 1300 m, Gj. (403), II; Kigezi Distr., Rubanda Co., Lake Bunyoro, Sharp's Island, 1800 m, Gj. (235), II.

Uredinia amphigenous, round, oblong or irregular, scattered or sometimes in rings around a central sorus, brown. Urediniospores ovoid, obovoid or ellipsoid, sometimes somewhat angular, 21-32(-37) x 17-24(-27) µm, wall 1.5-2 µm thick, brown, delicately echinulate with 2(-3) superequatorial pores. Telia hypophyllous, between uredinia, roundish, oblong, scattered, pulvinate, brown. Teliospores cylindrical or obclavate, rounded at apex, constricted at septum, 37-51 x 17-24 µm, wall 1 um thick, at apex thickened to 5.5 µm, cinnamon-brown at apex, paler to the pedicel, smooth, upper pore apical, lower pore obscure. Pedicel hyaline, often broken a few um below the spore.

The spores vary much in size and also in form. The pores are superequatorial, on P. setosulum often close to apex, but sometimes one of the two pores (three pores are very rare) is equatorial, sometimes even lower.

Wakefield & Hansford (1949) reported P. polygoni-amphibii from Kisoro in Kigezi and from Jinja and Ripon Falls in Busoga on Polygonum acuminatum H.B. & K. and P. sp. (= O. sinuatum, det. K.A. Lye, K), resp. On O. sinuatum they reported it from Kyagwe and Kampala. The rust on P. setosulum was reported as Uromyces polygoni-avicularis (Pers.) Karst. from Kizoro by Ebbels (1972, IMI 155313) and from Ruwenzori Mts. by Henderson (1970, IMI 171982), from Kenya as P. polygoni-weyrichii Miyabe by Nattrass (1961, IMI 80465) and as P. sp. by Mogk & Hindorf (1971, IMI 148652). The urediniospores of U. polygoni-avicularis have equatorial pores while they in P. polygoni-weyrichii have basal pores. Other African hosts are O. atriplicifolium (Meisn.) Martel, P. amphibium L., P. convolvulus L. and P. tomentosum Willd. (= P. pulchrum Blume).

The aecial stage has been reported only from Algeria on Geranium atlanticum Boiss. & Reut.

Puccinia saniculae Grev., Fl. Edinb. p. 431, 1824.
On Sanicula elata F. Ham. ex D. Don
Bugisu Distr., N. Bugisu Co., on track between Sasa River and Sasa Hut, c. 3000 m, Gj. (410), 0 + I.

Pycnia amphigenous. Aecia hypophyllous, in small clusters, with white peridia, cupulate, short. Aeciospores angular or subgloboid to globoid, 16-26 x (13-)16-24 µm, wall c. 1 µm thick, hyaline, finely and densely verrucose.

P. saniculae is widespread in Europe on S. europaea, in Asia it is also found on other Sanicula spp. from

Caucasus and Asia Minor eastwards to China, Far East Siberia and Japan. To my knowledge no rust has been reported on Sanicula in Africa.

Puccinia tragiae Cooke, Grevillea 10: 125, 1882.
On Tragia cordifolia Benth. (Euphorbiaceae)
Mubende Distr., Singo Co., Mile 70 at the Kampala-Hoima road, 1400 m, Gj. (301), I.

Aecia hypophyllous, in groups on brown leaf spots. Peridium white. Aeciospores angular, ellipsoid or subgloboid 18-23 x 15-18 µm, wall less than 1 µm thick, hyaline, densely verruculose.

Wakefield & Hansford (1949) reported this rust from Elgon, Sebei on T. brevipes Pax and on T. sp. from Serere in Teso. It is reported from Ethiopia, Kenya, Tanzania, Somali and S. Africa on T. sp., in S. Africa also on T. rupestris Sond. T. cordifolia is a new host for this rust.

Puccinia violae DC., Fl.Fr. 6: 62, 1815.
On Viola abyssinica Steud. ex Oliv. (Violaceae)
Kenya. Central Prov., Mt. Elgon, Suam Forest Station, 2100 m, 23.-24.01.1973, L. Ryvarden (9257, O), II.

Uredinia mainly hypophyllous, brown, scattered or confluent, pulverulent, brown. Urediniospores obovoid to subgloboid or ellipsoid, 20-27 x 19-23 µm, wall 1-1.5 µm thick, golden brown, echinulate and with 2 equatorial pores covered by hyaline papillae.

In Africa this elsewhere widespread rust is known only from Madeira, Canary Island, Algeria and Morocco. V. abyssinica is a new host for the rust.

Puccinia zorniae McAlp., Rusts of Australia p. 172, 1906.
On Zornia pratensis Milne-Redh. ssp. pratensis (Fabaceae)
W. Mengo Distr., Kyadondo Co., Makerere Hill, 1200 m, 30.10.1962, Mukiibi, II(+III).

Uredinia hypophyllous, scattered, brown. Urediniospores obovoid, ellipsoid or subgloboid, 22-30 x 20-26 µm, wall 2.5(-3) µm thick, brown to dark brown, echinulate, with 2 equatorial pores, covered by low, hyaline papillae. A few teliospores in the uredinia, ellipsoid, rounded in both ends, constricted at septum, 38-44 x 23-26 µm, wall 3 µm thick, brown, smooth, upper pores apical with a low, wide hyaline papilla, the lower pore equatorial.

Wakefield (1920) reported Uredo zorniae Diet. on Zornia sp. from Lumbwa in Kyagwe. Later Wakefield & Hansford (1949) published under P. zorniae two collections on Z. diphylla Pers., from Kampala and from Katakwi in Teso, together with the first mentioned specimen.

The rust, described from New South Wales, is also reported from Kenya, Rwanda, Nigeria, Côte d'Ivoire, Mauritius and S. Africa. The report of P. zorniae on Z. diphylla from Brazil (Batista et al. 1966) might be erroneously as they described it having urediniospores with 3 pores as have P. arachidis Speg. var. offuscata (Arth.) Cumm. (syn. P. offuscata Arth.).

The identity of *Z. diphylla* is uncertain, but it might be *Z. pratensis* (cf. Flora of Tropical East Africa, Leguminosae (Part 3), Subfam. Papilionoideae, 1).

Ravenelia albiziae-zygiae Deighton, Trans. Brit. mycol. Soc. 55: 496, 1970.
Syn. *R. zygiae* H. Syd., Annls mycol. 36: 157, 1938, illeg.
On *Albizia zygiae* (DC.) Macbr. (syn. *A. brownei* Walp.) (Fabaceae)
E. Mengo Distr., Buruli Co., Mile 125 on the Kampala-Masindi road, 1250 m, Gj. (360), II + III.

Uredinia hypophyllous, brown. Urediniospores ellipsoid, obovoid or sometimes subgloboid, 23-27 x 16-23 µm, wall yellowish brown, 1.5 µm thick, at apex thickened to 3 µm, verrucose and with 2 equatorial pores. Telia hypophyllous, brown. Telial heads brown, 43-62 µm in diam., with three internal and six marginal spores, the latter with several spines.

This rust is wide-spread in Africa, recorded mainly as *R. zygiae* on *A. zygia*, its main host. Wakefield & Hansford (1949) published the rust from many localities in Uganda and in addition to *A. zygia* (incl. *A. brownei*) also on *A. gummifera* (Gmel.) C.A. Sm.

Ravenelia cassiaecola Atk. var. berkeleyi (Mundk. & Thirum.) Cumm. & Baxt., Mem. N.Y. bot. Gdn 28: 38, 1976.
O *Cassia absus* L. (Fabaceae) n
Tanzania. Iringa Distr., Ruaha Nat. Park, 5 km N of Msembe, 880 m, 22.04.1971, A. Bjørnstad (883, O), II + III.

Uredinia amphigenous, yellowish brown. Urediniospores ellipsoid or obovoid, sometimes flattened at one side, 15-25 x 12-15 µm, wall yellowish brown 1.5-2.5(-3) µm thick, echinulate and with scattered pores. Telial heads amphigenous, brown, 80-100 µm in diam. with 5-6 spores across, smooth.

C. absus is the main host for this variety, known also from the Americas and from India. In Africa Angus (1966) reported it from Zambia and Ebbels & Allen (1979) from Tanzania.

The var. *cassiaecola* is a North and Central American taxon, occurring on several *Cassia* species.

Ravenelia hansfordii Cumm., Bull. Torrey Bot. Club 72: 214, 1945, var. hansfordii.
On *Acacia senegal* (L.) Willd. var. *leiorhachis* Brenan (Fabaceae)
Tanzania. Iringa Distr., Ruaha Nat. Park, 4 km NE of Msembe, 860 m, 16.04.1971, A. Bjørnstad (802), II + III.

Uredinia hypophyllous, dark brown. Urediniospores ellipsoid, 19-27 x 12-18 µm, wall yellowish brown, 1,5 µm thick, some spores slightly thickened at apex, echinulate and with 4 equatorial pores. Telia amphigenous, dark brown. Telial heads brown, 62-86 µm in diam, 5-7 spores across, with low spines.

This variety, described on Acacia sp. from Serere in Teso (also ref. by Wakefield & Hansford 1949), is new to Tanzania, and the host is new to the rust.

From India Ramakrishnan & Sundaram (1953) described var. ferruginea having shorter urediniospores.

Ravenelia indigoferae Tranz., Hedwigia 33: 369, 1894.
On Indigofera emarginella A. Rich. (Fabaceae)
Bunyoro Distr., Bugahya Co., Hoima, 1500 m, Gj. (326), II + III.

Uredinia amphigenous, small, scattered, cinnamon-brown and with spathulate or capitate paraphyses, slightly thickened at apex. Urediniospores ellipsoid or obovoid, 18-24 x 13-17 µm, wall 1-1.5 µm thick, cinnamon-brown, echinulate and with scattered pores. Telial heads in small groups, sometimes in the uredinia, dark brown, 70-117 µm in diam., mostly 5 cells across, with small spines.

R. indigoferae, widespread in the Americas, has been reported from Mt. Elgon by Wakefield & Hansford (1949) and from Kasambya by Henderson (1970), the former authors on I. sp., the latter on I. emarginella. On the same host it has been reported from Tanzania and Malawi. It is also found in Zimbabwe.

The rust has been found on Indigofera spp. in the Americas, and it occurs also in the Philippines and in China.

Ravenelia tephrosiae Kalchbr. in Parker, Proc. Am. Acad. Arts Sci., 22, New Ser. 14, Part I, Boston, p. 217, 1836.
On Tephrosia barbigera Bak. (Fabaceae)
E. Mengo Distr., Buruli Co., Mile 125 on the Kampala-Masindi road, 1250 m, Gj. (358), II + III.
On Tephrosia nana Schweinf.
Masaka Distr., Buddu Co., Bugabo, SW of Lake Nabugabo, 01.02.1969, K.A. Lye (1781), II.

Uredinia amphigenous, small, scattered, irregular, cinnamon-brown. Urediniospores ellipsoid, 18-25 x 15-20 µm, wall 1.5-2 µm thick, nearly hyaline, echinulate with several equatorial pores. Telial heads hypophyllous in small groups, brown to dark brown, 100-135 µm in diam., 6-8 spores across, each spore with several spines, 100-135 µm in diameter.

This rust is new to the rust flora of Uganda, and both hosts are new to the rust. It is previously known from Zimbabwe (Hopkins 1938) and S. Africa (Doidge 1926).

Uredo achyranthicola Cumm., Bull. Torrey Bot. Club 72: 219, 1945.
On Achyranthes aspera L. (Amaranthaceae)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (283), II.

Uredinia epiphyllous, small, round to oval, light cinnamon-brown. Urediniospores obovoid to subgloboid, 22-24 x 19-22 µm, wall 1-1.5 µm thick, pale yellow, sparcely echinulate, pores obscure.

This rust species is described from Kisoro in Kigezi. Wakefield (1920) had previously recorded a rust as U. achyranthis P. Henn. from Kipayo, but this specimen is not mentioned neither by Cummins (op.cit.) nor by Wakefield & Hansford (1949). However, the Sydows (1924) had pointed out that Hennings' fungus was an Albugo (cf. also Laundon 1965). U. achyranthicola is known on the same host from Ethiopia (Castellani & Ciferri 1950).

In China a similar rust, described as U. verecunda H. Syd., occurs on the same host, differing chiefly in the position of the sori which are hypophyllous (Laundon 1965). The same rust has been found on A. bidentata Blume (type host) in India.

Uredo stylosanthis P. Henn., Hedwigia 38: 68, 1899.
On Stylosanthes fruticosa (Retz.) Alston (syn. S. bojeri Vogel, S. mucronata Willd.) (Fabaceae)
Bugisu Distr., Central Bugisu Co., 2-3 km N of Busoba, 31.05.1969, K.A. Lye (3130), II.

Uredinia hypohyllous, irregular, dark reddish brown. Urediniospores globoid, ellipsoid or obovoid, 23-30 x 20-25 µm, wall 2.5-3 µm thick, cinnamon-brown, echinulate and with 2 equatorial pores.

Wakefield & Hansford (1949) recorded this rust from Serere in Teso. It is also known from Rwanda, Ethiopia and S. Africa. Originally it was described from Brazil, and the Sydows (1924) stated that the African rust corresponded exactly to the Brazilian one. Viégas (1945) described and illustrated Puccinia stylosanthis (P. Henn.) n.sp. on S. guianensis (Aubl.) Ser. However, the diagnosis is not in Latin and therefore the name is not validly published. As I have not seen the Brazilian specimen, I prefer to list the African specimen as Uredo stylosanthis.

Uredo desmodii-ramosissimi n.sp. (Fig. 10)

Uredinia hypophylla, parva, rotundata vel ovalia, confluentia, pulverulenta, cinnamomea. Urediniosporae globoideae vel obovoideae, 18-23 x 17-20 µm, pariete 1.5-2 µm crasso, cinnamomeo, subtiliter echinulato, poris (2-) 3(-4) equatorialibus vel superequatorialibus instructis, pedicello hyalino.
Holotype: H.B. Gjærum 74 (MHU), Uganda, W. Mengo Distr., Busiro Co., Zika Forest, 1160, 09.09.1970 on Desmodium ramosissimum G. Don. (Fabaceae). Isotype in NPPI.
Other material:
On Desmodium dregeanum Benth. (syn. D. caffrum (E. Mey.) Druce).
W. Mengo Distr., Mawokota Co., 3-4 km N of Masaka Border, 1140 m, 01.02.1970, K.A. Lye & R.Wh. Haines (5039), II.

Several rust species have been described on Desmodium spp. from warmer areas in the Americas and Asia, but to my knowledge on none from Africa.

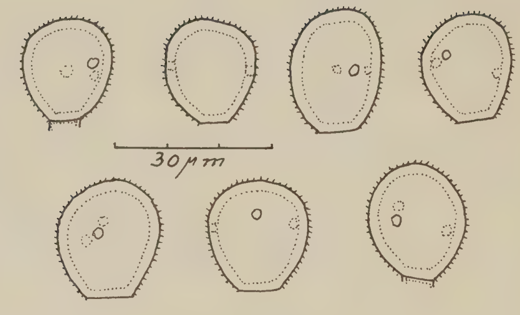

Fig. 10. *Uredo desmodii-ramosissimi*
Urediniospores from type.

Uromyces appendiculatus (Pers.) Unger, Einfl. Bodens p. 216, 1836, var. appendiculatus.

Syn. *Uromyces phaseoli* (Pers.) Wint., Hedwigia 19: 37, 1880.

On *Phaseolus vulgaris* L. (Fabaceae)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (284, 287, 473), II, Busiro Co., Kisibawo, 1200 m, Gj. (191), II + III; Teso Distr., Soroti Co., Arapai Research Station, 1100 m, Gj. (418), II.

Uredinia amphigenous, irregular, cinnamon-brown. Urediniospores subgloboid to obovoid, 22-25 x 19-23 µm, wall 1-1.5 µm thick, finely echinulate and with 2 equatorial pores, covered by low hyaline papillae. Telia amphigenous, irregular, dark brown. Teliospores ellipsoid, often somewhat irregular, 19-32 x 17-23 µm, wall 3-3.5 µm thick, dark brown, smooth or with a few indistinct warts, pore apical with a hyaline to pale brown papilla. Pedicel hyaline, up to 40 um long.

Wakefield & Hansford (1949) reported this rust on *Ph. mungo* L. from Kipayo in Kyagwe and from Kampala, and on *Ph.* sp. from Kabale in Kigezi. On *Ph. vulgaris* this rust probably follows the host everywhere and often causes great damage.

Uromyces cluytiae Kalchbr. & Cooke, Grevillea 11: 20, 1882, var. cluytiae.

Syn. *U. cluytiae* Kalchbr. & Cooke var. *erythraeensis* P. Henn., Bull. l'Herb. Boissier 1: 108, 1893.

On *Clutya abyssinica* Jaub. & Spach (Euphorbiaceae)
Karamoja Distr., Mathenico Co, Mt. Moroto, SE of Sogolomon, 2300 m, 11.06.1970, K.A. Lye (M 18C), II + III.
Kenya. Elgon, 10500', 22.12.1966, A.C. Hamilton, III.
On *Clutya robusta* Pax
Kenya. On the road Nakuru-Thompson's Falls, 8000', 03.01.1961, A.K.M., III.

Uredinia hypophyllous, irregular, pale brown. Urediniospores ellipsoid, obovoid to subgloboid, 25-37 x 23-29 µm, wall 1-1.5 µm thick, yellow-brown, echinulate, pores scattered, obscure. Telia in the uredinea, dark brown. Teliospores ellipsoid, often slightly oblique, rarely misformed, 34-48 x 18-24 µm, wall yellowish brown, 1.5 µm thick, at apex paler and thickened to 4.5-5 µm, densely verrucose. Pedicel often broken short under the spore, hyaline.

This rust species is widespread in Africa on several Clutia spp. Wakefield & Hansford (1949) reported the var. cluytiae from Kabaroni in Mt. Elgon. The var. minor Wakef. which has smaller teliospores with more finely verrucose wall, was described on C. richardiana Mull.-Arg. (type) from Mt. Elgon and on C. abyssinica Jaub. & Spach from Nyarusanje in Kigezi.

Henderson (1970) found urediniospores in the telia. He indicated that this rust "is almost certainly a microform derived from a heteroecious species with aecia on Euphorbia and dicaryont stages on Leguminosae". In the material seen by me there are sori with only urediniospores, some sori where also teliospores occur, and telia where only teliospores occur.

C. abyssinica is a new host for this rust in Kenya and C. robusta for it in Uganda.

In two of the specimens, viz. on C. abyssinica (Lye M18 C) and on C. robusta, there are also a few aecia, but they are not on the same leaves as are the telia. The aecia are amphigenous, in small clusters, and with ellipsoid or subgloboid, often somewhat irregular spores, 27-39 x 22-30 µm, with a hyaline wall less than 1 µm thick and with reflecting bodies. Whether they belong to U. cluytiae or not, is uncertain.

Winter has in sched. mentioned Aecidium cluytiae on C. pulchella L. and C. abyssinica from Ethiopia, but the Sydows (1910) stated that "Die hiervon existierenden Exemplare sind sehr dürftig; ob dasselbe zu Uromyces Cluytiae gehört, bleibt fraglich".

Aecidium cluytiae Doidge was described on C. virgata Bax. from Transvaal in S. Africa. The aecia cover the entire lower leaf surface, and the species has much smaller spores, 16-22 x 15-17 µm, with a thicker wall, 2-2.5 µm, than has the aeciospores seen by me.

Uromyces crotalariae (Arth.) W. Baxt., Mycologia 54: 437, 1962.
Syn. Uropyxis crotalariae Arth., Am. J. Bot. 5: 429, 1918; Haplopyxis crotalariae (Arth.) H. & P. Syd., Annls mycol. 17: 105, 1919; Uromyces harmsianus Doidge, Bothalia 2: 22, 1927.

On Crotalaria incana L. (Fabaceae)

Bunyoro Distr., Bugahya Co., Hoima, 1500 m, Gj. (334), II.

On Crotalaria ononoides Benth.

Teso Distr., Serere Co., Serere Research Station, 1150 m, Gj. (436), II.

On Crotalaria petitiana (A. Rich.) Walp.

West Nile, Vurru Co., 3 km NW of Uleppi, 1100 m, 12.09.1969, K.A. Lye & R.N. Lester (2175).
On *Crotalaria* sp.
Kenya. Eastern Prov., Nyeri Distr., Mt. Kenya, S slope, Regati Forest Station, 2200-2300 m, 02.-03. Febr. 1973, L. Ryvarden (9125, O), II.

Uredinia hypophyllous, irregular, scattered or in groups, light cinnamon-brown. Urediniospores globoid to obovoid, 24-25 x 24-30 µm, wall 1.5-2.5 µm thick, light cinnamon-brown, echinulate with several pores, scattered or arranged in two levels, with low papillae.

Wakefield & Hansford (1949) reported this rust species under *U. harmsianus* on *C. striata*, *C. intermedia* and *C.* sp. from W. Mengo and Teso. It is recorded on several species of *Crotalaria* from Kenya, Tanzania and S. Africa, and it is also known from Central and S. America. The three hosts mentioned above are new to this rust.

Other *Uromyces* species on *Crotalaria* spp. in Africa are *U. decoratus* Syd. which has urediniospores with 4-6 more or less equatorial pores (cf. Punithalingam 1968) and *U. africanus* (Gjærum) Ono which is lacking uredinia.

Uromyces euphorbiae Cooke & Peck in Peck, Ann. Rep. N.Y. State Mus. 25: 90, 1973.
Syn. *Urom. proëminens* Pass. in Rabenh. Fung. Eur. 1795, 1874, *Urom. euphorbiicola* Tranz., Annls mycol. 8: 8, 1910.
On *Euphorbia prostrata* Ait. (Euphorbiaceae)
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (268), II + III; Ankole Distr., Kashari Co., Mbarara, 1200 m, 20.6.1967, Basasibwaki, II.

Uredinia hypophyllous, irregular, cinnamon-brown. Urediniospores ellipsoid or obovoid, sometimes ovoid, 18-23 x 15-20 µm, wall 2.5-3 µm thick, cinnamon-brown, echinulate and with 3-5 pores more or less equatorial, one sometimes apical.

Telia as uredinia, chestnut-brown, pulverulent. Teliospores ovoid to subgloboid, 20-22 x 16-20 um, wall 1.5-2 µm thick, chestnut-brown, verrucose and with apical pore covered by a low papilla. Pedicel hyaline, often broken below the pore.

E. prostrata is a new host for this rust in Uganda, but it is reported from Tanzania, Zambia and Ghana. Wakefield & Hansford (1949) published this rust as *U. proëminens* on *E. inaequilatera* Sond. from Kabaroni and Sipi in the Mt. Elgon area. It is widespread in Africa on several species of *Euphorbia* as it is in warmer regions in other continents. For nomenclature and taxonomy cfr. Jørstad (1956, 1956a).

Uromyces geranii (DC.) Lév., Ann. Sci. Nat., Bot., III, 371 & 376, 1847.
On *Geranium arabicum* Forsk. (syn. *G. simense* A. Rich.) (Geraniaceae)
Kenya. Eastern Prov., Aberdare Mts., Kimabia Forest Station, 2200-2400 m, 16.-18.01.1973, L. Ryvarden (9100,

O), II; Central Prov., Mt. Elgon, Suam Forest Station, 2100 m, 23.-24.01.1973, L. Ryvarden (9261, O), II.
Tanzania. Kilimanjaro, above Marangu, below Peter's Hut, 3350 m, 21.06.1948, O. Hedberg (1333, UPS), II.
On Geranium sp.
Kenya. Central Prov., Suam Forest Station, 2100 m, 23.-24.01.1973, L. Ryvarden (9262b, O), II.

Uredinia hypophyllous, brown, irregular, scattered or in small groups, often confluent. Urediniospores subgloboid to globoid or broad ellipsoid, 22-33 x 21-31 µm, wall 2-3 µm thick, brown to yellowish brown, echinulate and with 1 equatorial pore, covered by a low, hyaline papilla.

Wakefield & Hansford (1949) reported this rust species on G. simense Hochst. from Kabale and Kachwekano in Kigezi.

In Africa this rust has also been reported in Ethiopia, Kenya and Tanzania, on G. simense og G. sp., from Kenya also on G. aculeolatum Oliv. (Nattrass 1961). It is widespread in Europe and Asia as well as in N. America.

Uromyces indigoferae Diet. & Holw., Bot. Gaz. 31: 328, 1901.
Syn. Uromyces orientalis H. & P. Syd., Annls mycol. 5: 490, 1907.
On Indigofera spicata Forsk. (Fabaceae)
W. Mengo Distr., Kyadondo Co., Namulonge, 1180 m, Gj. (92), II.
On Indigofera strobilifera (Hochst.) Bak.
Tanzania. W. Prov., near Tabora, 26.04.1962, A.C. Tallantire (278), II + III.

Uredinia amphigenous, irregular, cinnamon-brown. Urediniospores obovoid to subgloboid, 20-25 x 17-22 µm, wall 1.5-2 µm thick, cinnamon-brown, echinulate and with 3-4 equatorial pores. Telia compact, blackish brown. Teliospores ellipsoid, sometimes wider than long, 28-33 x 21-33 µm, wall (2-)2.5-3.5(-4) µm thick, at apex thickened to 11 µm, smooth, cinnamon-brown. Pedicel hyaline, persistent.

Wakefield & Hansford (1949) brought records of this rust on I. polysphaera Baker from Serere in Teso and on I. sp. from Kampala and from Bukwa in the Mt. Elgon area. It is known on I. spicata from Zambia while I. strobilifera seems to be a new host for the rust which is new to the flora of Tanzania. Other African hosts are I. baumiana Harms and I. sutherlandioides Bakdi in Zambia, and on I. arrecta A. Rich. in Ethiopia. It is also known from Kenya and Malawi (on I. spp.). Outside Africa it is widespread in Asia, and also in Australia and the Americas.

Uromyces pseudarthriae Cooke, Grevillea 10: 127, 1882.
On Pseudarthria hookeri Wight & Arn. (Fabaceae)
Mubende Distr., Singo Co., Hoima road, Mile 70, 1400 m, Gj. (302, 303), II + III.

Uredinia hypophyllous, round, confluent, cinnamon-brown. Urediniospores subgloboid to globoid, 18-22 x 18-21 µm, wall 1 µm thick, pale cinnamon-brown, finely echinulate and with 3-4 scattered, obscure pores. Telia hypophyllous, dark brown, round, confluent. Teliospores subgloboid to globoid, sometimes wider than high, 22-29 x 23-27 µm, wall brown, 2.5-3.5 µm thick, slightly increasing from pedicel to apex, 4-4.5 µm, densely verrucose, pore apical with a low papilla. Pedicel hyaline, deciduous.

Wakefield & Hansford (1949) reported this rust on the same host, the only known in Africa, as common everywhere. Outside Uganda it is reported from S. Africa and probably Togo. In Asia it is known on Pseudarthria sp. in Sri Lanka, and in India and the Philippines on P. viscida W. & A.

Uromyces rhynchosiae Cooke em. Doidge, Bothalia 4: 911, 1948.
Syn. Uromyces rhynchosiae Cooke, Grevillea 10: 127, 1882 (based on uredinia).
On Rhynchosia sp. (Fabaceae)
Karamoja distr., Mathenico Co., Mt. Moromoto, SE of Sogolomon, 2600 m, 11.06.1970, K.A. Lye, A.B. Katende and D. Swinscow (5619), II.

Uredinia hypophyllous, irregular, scattered, chestnut-brown. Urediniospores globoid to ellipsoid, 24-28 x 20-27 µm, wall 2-2.5 µm thick, cinnamon-brown, 2-3(-4) equatorial pores with low, hyaline papillae.

This rust was recorded by Wakefield & Hansford (1949) under U. dolichi Cooke on R. densiflora DC. from Mbarara. It is knowm from Tanzania, Malawi, Zambia and Rwanda on some other species of Rhynchosia and also on species of Eriosema and Flemingia.

The nomenclature has been discussed by Doidge (1948).

Uromyces striatus Schroet., Abh. Schles. Ges. Vaterl. Cult., Nat. Abth. 1869-72: 11, 1870.
On Medicago sativa L. (Fabaceae)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (463), II.

Uredinia amphigenous, scattered, roundish, brown. Urediniospores subgloboid to ellipsoid, 19-23 x 15-20 µm, wall 1.5 µm thick, pale brown to yellowish, echinulate, with 3-4 more or less equatorial pores with hyaline papillae.

This circumglobal alfalfa rust was reported by Wakefield (1920) from Mularye in Kyagwe, later also by Wakefield & Hansford (1949) from Serere in Teso. In Africa it is known on other Medicago spp., in Libya also on Hymenocarpon spp.

Uromyces vignae Barcl., J. Asia. Soc. Beng. 60: 211, 1891.
Syn. U. phaseoli (Pers.) Wint. var. vignae (Barcl.) Arth., Man. Rusts U.S. and Canada p. 297, 1934.
On Vigna unguiculata (L.) Walp. (Fabaceae)
E. Mengo Distr., Buruli Co., Mile 125 on the Kampala-

Masindi road, 1250 m, Gj. (357), II; Bunyoro Distr., Bujenje Co., Itutwe borehole near Biso, 1050 m, Gj. (340), II, and Butiaba, 620 m, Gj. (342), II.
On *Vigna vexillata* (L.) A. Rich.
Mubende Distr., Singo Co., swamp W of Lake Kioga, on the Hoima road, 1100 m, Gj. (316), II.

Uredinia amphigenous, irregular, cinnamon-brown. Urediniospores subgloboid, obovoid or ellipsoid, 23-29(-35) x 18-25 µm, wall 1.5-2 µm thick, cinnamon-brown, echinulate and with 2 superequatorial pores covered by low, hyaline papillae.

This widespread cowpea rust was reported by Snowden (1921), and by Small (1926) as *U. appendiculatus* (Pers.) Unger on *Vigna sinensis*. Later Wakefield & Hansford (1949) reported it as *U. phaseoli* (Pers.) Wint. (=*U. appendiculatus*) on *V. unguiculata* from Kamuli in Busoga and on *V.* sp. from Kampala. *V. vexillata* sems to be a new host for this rust in Uganda, but it is mentioned from Sudan and Taiwan. Another African host is *Lablab purpureus* (L.) Sweet (syn. *Dolichos lablab* L.).

U. appendiculatus differs from *U. vignae* in having urediniospores with 2 equatorial, more obscure pores.

Aecidium vignae Cooke described on *Vigna marginata* Benth. from Natal, has been found in Uganda on *Pueraria phaseoloides* and *Vigna* spp. (Wakefield & Hansford op.cit.). It is also known from other African countries and from Sri Lanka. Another host genus is *Sphenostylis*. Judging from descriptions given in the literature it seems quite similar to the aecial stage of *U. vignae*, but have a slightly thicker wall, 1.5-2 µm and 1-1.5 µm, respectively.

Uromyces wiehei Cumm., Bull. Torrey Bot. Club 79: 233, 1952.
On *Thalictrum rhynchocarpum* Dill. & A. Rich. (Ranunculaceae)
Kenya. Eastern Prov., Nyeri Distr., Mt. Kenya, S slope, Regati Forest Station, 2200-2300 m, 02.-03.02.1973, L. Ryvarden (9802, 0), II.

Uredinia hypophyllous, round to oblong, with hyaline, capitate paraphyses, cinnamon-brown. Urediniospores ellipsoid or subgloboid, 21-27 x 18-22 µm, wall 1-1.5 µm thick, nearly hyaline, echinulate and with several scattered pores.

U. wiehei was described from Zomba, Malawi, and later reported from Kenya and Uganda (cf. Bisby & Wiehe 1953). The only host mentioned is *Th. rhynchocarpum*.

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MYCOTAXON

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A NEW SPECIES OF PETRAKINA (LOCULOASCOMYCETES)

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During the routine identification of fungi on plant material intercepted by Plant Protection and Quarantine inspectors (USDA,APHIS,PPQ) a fungus was observed on a member of the Palmae that could not be accommodated in any known taxon. The fungus is described herein as a new species of *Petrakina* Cif., a table is presented comparing the characteristics of the two known species of *Petrakina*, and the taxonomic position of the genus is discussed.

PETRAKINA DISCOIDEA Farr & Palm, sp. nov. Figs. 1-15

Fungus amphigenus, effusus. Mycelium reticulatum, subhyalinum vel pallide brunneum, ex hyphis sinuosis 3-5 µm crassis constans, stomatopodiis numerosis brunneis cellulosis vel verticaliter fibrosis 5-12 µm crassis formans. Ascomata gregaria, nigra, orbicularia, ad maturitatem discoidea; scutello (120-)216-336 µm diam, 80-136 µm alto texturae epidermoideae vel irregulariter subradiatae, irregulariter stellatim rumpenti tum pro parte majore fatiscenti, margine pro parte fimbriato in mycelium transienti; loculo 120-215 µm, pariete et membrana basali ex hyphis delicatulis pallide brunneis constans. Asci bitunicati, oblongi ad ellipsoidei, basin versus attenuati, 56-88 x 16-22 µm, 8-spori, pariete apice ad 10 µm crasso; filis sterilibus hyalinis septatis undulatis simplicibus vel ramosis 40-50 µm longis 0.5-1.5 µm crassis. Ascosporae distichae, clavulatae ad ellipsoideae vel subfusoideae, 16-24 x 6-11 µm, ad septum medium leniter constrictae, juventute hyalinae et transverse 3-septatae, maturitatem brunneae, transverse 4-septatae et in longitudinem 0-2-septatae.

Holotypus. MEXICO: Tamaulipas, Ciudad Victoria, on living leaves of an undetermined species of palm intercepted at Brownsville, TX, U.S.A., by J. M. Van Valkenburgh, 13 Aug. 1984, BR-14607 TX (BPI 71939).

Colonies amphigenous, effuse, covering large areas of the leaf surface with a thin gray coating. Mycelium superficial, reticulate, subhyaline to pale brown, consisting of sinuous hyphae 3-5 µm diam (Fig. 1), forming numerous stomatopodia of vertical brown hyphae or cell complexes 5-12 µm diam (Figs. 1-3). Ascomata closely gregarious, sometimes 2-3 fused, distributed over the entire colony, black, orbicular, initially flat, at maturity opening wide (Fig. 6) and becoming shallowly discoid, consisting of a scutellum covering a slightly smaller, ± discretely walled locule (Fig. 4); dehiscence starting as a ± stellate rupture, followed by disintegration of all except the peripheral region of the scutellum (Figs. 5,6); scutellum (120-)216-336 µm diam, 80-136 µm high, 4-10 µm thick, of epidermoid or sometimes irregularly radiate texture, blending at the margin into the mycelium; locule 120-215 µm diam, bordered by delicate, pale brown hyphae; basal membrane delicate, light brown (Fig. 4). Asci bitunicate, 8-spored, oblong to ellipsoid, attenuated at base, 56-88 x 16-22 µm, with wall thickened up to 10 µm at apex (Fig. 7); interthecial filaments hyaline, septate, wavy, simple or branched, 40-50 µm long, 0.5-1.5 µm thick. Ascospores distichous, clavulate to ellipsoid or subfusoid, 16-24 x 6-11 µm, slightly constricted at median septum, hyaline and transversely 3-septate when young, light to medium brown and with 4 transverse and 0-2 longitudinal septa at maturity

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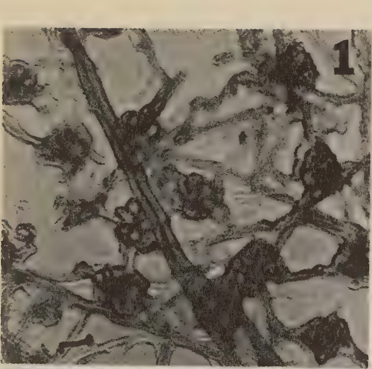
FIGS. 1-8. *Petrakina discoidea*. 1,2. Mycelium and stomatopodia; 1. X400; 2. X1000. 3. Longitudinal section through stomatopodium, phase contrast, X1000. 4. Longitudinal section through ascoma, showing small spaces (arrows) between locule and scutellum, phase contrast, X400. 5. Young ascoma, X140. 6. Two mature ascomata, showing disintegration of scutellum, X100. 7. Portion of hymenium, X400. 8. Ascospore, phase contrast, X1000.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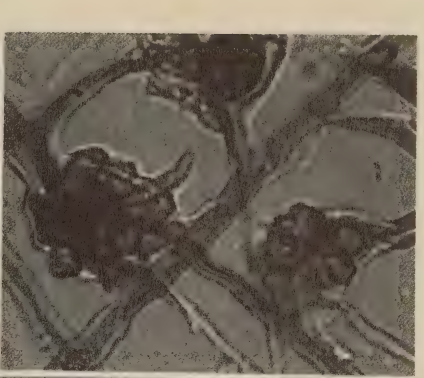
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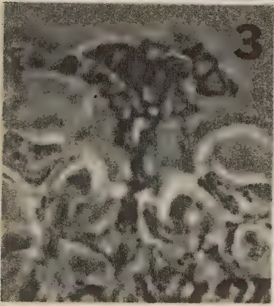
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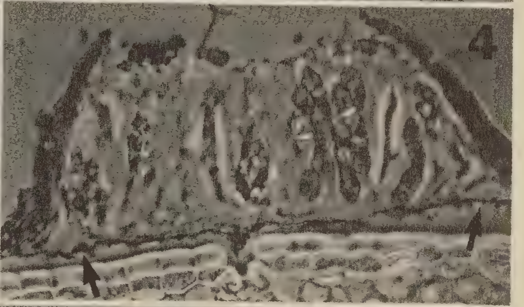
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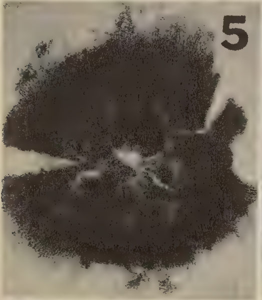
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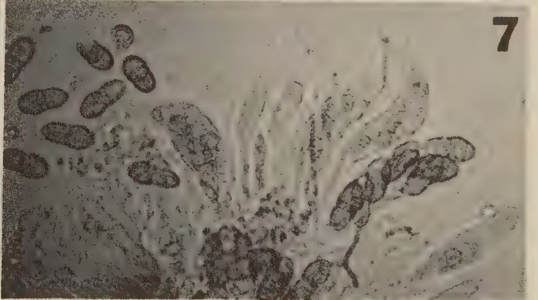
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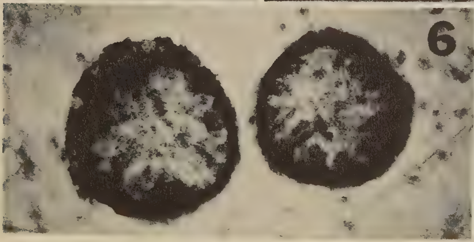
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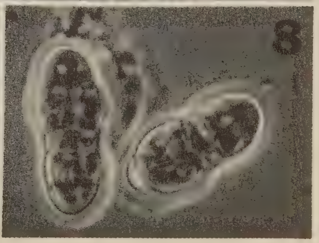
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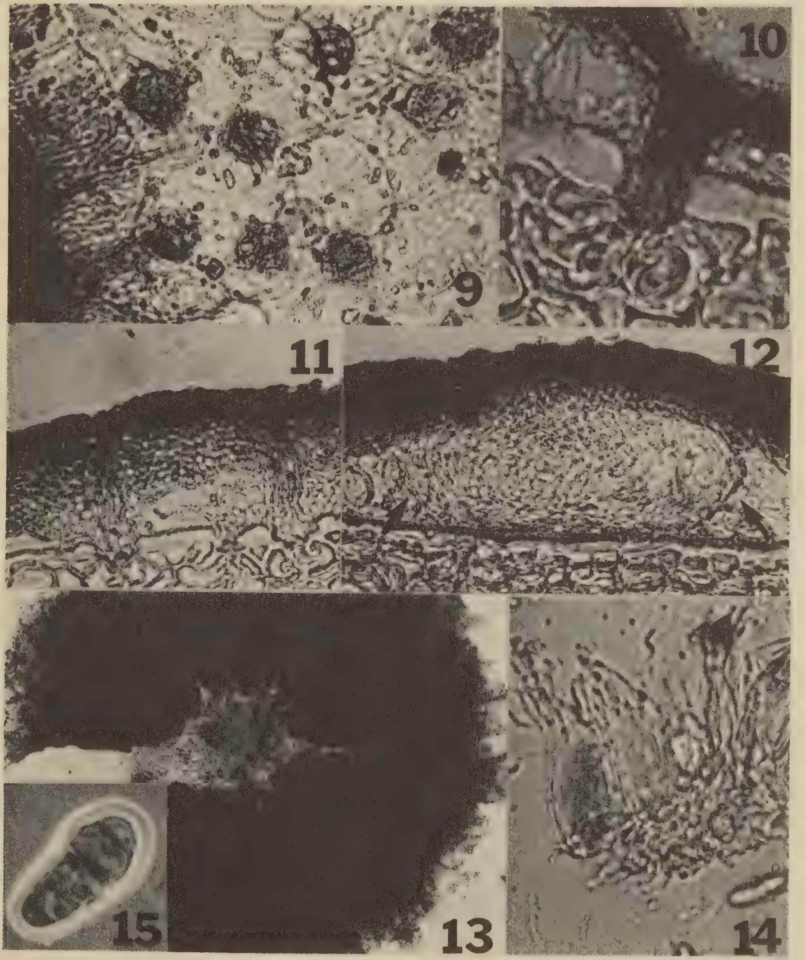
(Fig. 8), the cells immediately above the median septum sometimes swollen.

This fungus was compared with type material of *Petrakina mirabilis* Cif. in Petrak and Ciferri, the type and only other species of *Petrakina*. While its ascomata are young, the new species resembles *P. mirabilis* rather closely, the morphological differences being of degree rather than kind (Table I): *Petrakina discoidea* has a more robust and sinuous mycelium, slightly smaller stomatopodia (Figs. 1,9), and more delicate, less abundant interthecial filaments (?paraphyses) than *P. mirabilis* (Figs. 7,14). At maturity however, after rupturing more or less stellately as in *P. mirabilis* (Figs. 5,13), most of the scutellum of *P. discoidea* disintegrates, so that the ascomata then resemble minute, flat apothecia. In *P. mirabilis* no evidence of scutellum disintegration was found, even in mature ascomata (Fig. 13). This further step in ascoma maturation seen in *P. discoidea* may signify an evolutionary sequence within the genus or may be sufficiently distinct to merit erection of a new genus for *P. discoidea*, but more collections are needed to ascertain the relationship of these fungi. For the present, because of their striking similarity in every other respect, it seems wiser to classify the two fungi congenerically rather than in two separate monotypic genera represented by one specimen each. No other suitable genus was found for *P. discoidea*.

The taxonomic disposition of *Petrakina* is problematic in that the combination of its traits does not correspond with the concept of any one family. Petrak and Ciferri (1932) concluded that *P. mirabilis* occupies an isolated position close to the "Micropeltineen"; Hansford (1946) included *Petrakina* as the only dictyosporous genus in the Microthyriaceae, subfamily Asterinellinae; Luttrell (1973) likewise classified it in the Microthyriaceae, close to *Yatesula* Sydow (which despite its absence of free mycelium is keyed by Arx and Müller [1975] in the Chaetothyriaceae); whereas Arx and Müller placed *Petrakina* in the Schizothyriaceae. The latter family, however, is characterized by an entirely superficial or intracuticular habit without stomatopodia or other mycelial penetration of the host. In the Microthyriaceae dehiscence is ostiolar and the asci converge in a ring toward a central column of sterile filaments. The formation, in *Petrakina*, of a perithecium-like locule covered by a hyphal scutellum (Fig. 12) also brings to mind



FIGS. 9-15. *Petrakina mirabilis*. 9. Mycelium and stomatopodia, X400. 10,11. Longitudinal sections through ascoma showing columns and stomatopodia; 10, X1000; 11, X400. 12. Longitudinal section through ascoma, showing locule (arrows) and portion of scutellum, X400. 13. Mature ascoma (note dark spores in pore), X100. 14. Portion of hymenium, X400. 15. Ascospore, phase contrast, X1000.

TABLE I

Comparison of the two known species of *Petrakina*

CHARACTER	*PETRAKINA MIRABILIS*	*PETRAKINA DISCOIDEA*
COUNTRY	Dominican Republic	Mexico
HOST	*Typha latifolia*	Palmae
HABIT	Amphigenous	Amphigenous
MYCELIUM	Reticulate, subhyaline to pale brown; hyphae often in fascicles at margins of ascomata, 2-4(-6) µm thick, somewhat wavy	Reticulate, subhyaline to pale brown, 3-5 µm thick, very wavy
STOMATOPODIA	Hyaline to brown, 8-18(-24) µm wide	Brown, 5-12 µm wide
ASCOMATA	(160-)200-320 µm; scutellum may extend to 720 µm; 40-80 µm high (120-160 µm high, *fide* diagnosis); dehiscence irregularly stellate, later forming a pore 70-125 µm in diam; scutellum 15-20 µm thick, *textura epidermoidea* or *subradiata* in center, ± *radiata* toward margin; basal membrane delicate, light brown	120-215 µm; scutellum may extend to 336 µm; 80-136 µm high; dehiscence irregularly stellate, later discoid; scutellum 4-10 µm thick, *textura epidermoidea* to irregularly *radiata*, at margin merging into mycelium; basal membrane delicate, light brown
MATURE ASCI	46-60(-90) x 15-24(-26) µm, clavate to subcylindric or ellipsoid, "thick-walled" (*fide* diagnosis)	56-88 x 16-22 µm, oblong to ellipsoid, wall thickened at apex to 10 µm
INTERTHECIAL FILAMENTS	Abundant, septate, hyaline, simple or branched, 1-2(-4) µm thick	Not abundant, septate, simple, up to 50 µm long, up to 1.5 µm thick
MATURE ASCOSPORES	Brown, 15-28 x 7-10.5 µm, broadly clavulate to ellipsoid or fusoid, with 3-5 transverse and 0-2 incomplete longitudinal septa (Fig. 15)	Brown, 16-24 x 6-11 µm, clavulate to ellipsoid or subfusoid, with 4-transverse and 0-2 longitudinal septa (Fig. 8)

the Chaetothyriaceae, but this family resembles the Schizothyriaceae in habit, while displaying ostiolar dehiscence as in the Microthyriaceae. The most appropriate provisional placement of *Petrakina* may well be in the Asterinaceae or the closely related (Arx and Müller, 1975) Parmulariaceae. The former family allows for all attributes of *Petrakina* except ascoma structure. Some genera of the Parmulariaceae have ascomata composed of discrete locules under a radiate or epidermoid scutellum, but all lack external mycelium and stomatopodia. The development and taxonomic significance of this type of ascoma structure in *Petrakina* cannot be determined at present because of insufficient available material and especially because it is much less evident in *P. discoidea* than in *P. mirabilis*.

Another noteworthy feature of *Petrakina* is the presence of vertical hyphal strands or columns, each ending in a stomatopodium (Figs. 10,11). These columns are more conspicuous in *P. mirabilis* than in *P. discoidea* and appear to be randomly scattered rather than involved with the demarcation of the locule. In *P. discoidea*, these structures were seen only in immature ascomata, or in the peripheral regions of the scutellum after dehiscence.

ACKNOWLEDGMENTS

We thank the curators of herbaria NY and W for lending type material of *Petrakina mirabilis* and A. Y. Rossman for reviewing the manuscript. Technical assistance was rendered by E. Lancaster.

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MYCOTAXON

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A NEW SPECIES OF *AMANITA* VII.

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Summary

Amanita roseophylla, a new species in subgenus *Amanita*, section *Amanita*, is described as new from Alabama.

Introduction

Most of the species in the genus *Amanita* produce a white deposit of basidiospores. As a result the lamellae almost always appear white. Occasionally, however, the lamellae may appear a pale creamy color, especially in specimens in the section *Lepidella*. But usually the presence of any distinct pigmentation in mature lamellae is quite rare. Therefore, the distinctly creamy-pink lamellae of *Amanita roseophylla* make this taxon quite unusual, particularly within section *Amanita*. It is on the basis of this feature combined with nonamyloid basidiospores, obscure marginal striations on the pileus, pale grayish volval material, and a marginate to submarginate basal bulb that *A. roseophylla* is considered a new species.

Amanita roseophylla Jenkins, sp. nov.
Holotypus: Alabama - cabin property of Dr. John Farmer, Lay Lake, Talladega Co., Al., 18. ix. 83, David T. Jenkins 1755(DTJ).

PILEUS: In orbe subspadix, clarior versus marginem; 20-40 mm in mensura diametrica; convexus, sed qui fit plano-convexus; summa glabrosa, cum margine exigue incurvata et tenuissime striata; contextu albo, tenui; velum universale ut panni tenues et floccosi, pallido-caniores, delicati, qui solent evanescere ut amanita senescit. LAMELLAE: gilviores-roseae, modice densae, late solutaea stipe; lamellulae quoque modice abundantes; truncatae. STIPES: albus ad palido-gilvum, 40-50 x 5-8 mm, cylindricus, maxime glabrosus; fartus ad cavum; contextu albo; bulbus basalis ovoideus; marginatus ad submarginatum; usque ad 20 x 17 mm; residua veli universalis pauca; quae apparent ut panni parvi, pallido-caniores, et floccois ad apicem bulbi basalis. Velum partiale albius, angustum, floccoso-membranosum, delicatum, quod evanescit ut amanita senescit. Nullus nec odor nec sapor distinctus. SPORES: 10.2-11.7(12.0) x 7.0-7.8(8.4) µm; non-amyloidei.

Basidiocarps solitary to gregarious, small. PILEUS: 20-40 mm diam, convex to plano-convex; golden-blonde on disc, lighter to near putty on margin (5C4 to 4B2, Kornerup & Wanscher, 1967); pileipellis membranous, fairly easily separable from flesh, glabrous; margin very slightly striate, usually slightly incurved; flesh white, 1-3 mm thick at center, tapering toward margin; remains of universal veil very sparce, as thin, floccose patches, pale grayish (5B1), randomly distributed, relatively delicate, usually disappearing with age. LAMELLAE: pinkish-white (9A2), moderately close, narrow, widely free, edges floccose from remnants of partial veil; lamellulae moderately abundant, truncate. STIPE: up to 50 x 7-8 mm, cylindric, mostly glabrous, white to pale cream; stuffed to hollow; flesh white; basal bulb ovoid, submarginate to marginate, up to 20 x 17 mm; remnants of universal veil few or absent, or, if present, then as slightly floccose, pale grayish (5B1) patches; partial veil whitish, narrow, floccose-membranous, striate above, floccose below, delicate, disappearing with age. Basidiocarp having no distinct odor or taste.

PILEIPELLIS: filamentous hyphae fairly densely interwoven, considerable gelatinization, 2-5 µm diam, with clamp connections; oleiferous hyphae scarce. PILEUS TRAMA: filamentous hyphae undifferentiated, moderately branched, 1.5-5.5 µm diam, with clamp connections; inflated cells abundant, fusiform to bacilliform, terminal, up to 175 x 38 µm. LAMELLA TRAMA: bilateral; filamentous hyphae undifferentiated, with clamp connections, 2-6.5 µm diam; inflated cells fusiform to clavate, some irregular in shape, terminal, up to 155 x 30 µm. SUBHYMENIUM: ramose, clamp connections very common. BASIDIA: up to 54 x 5.5-11.7 µm, 2,3,4-sterigmate, thin-walled, with clamp connections. UNIVERSAL VEIL: filamentous hyphae moderately abundant, 2-5.5 µm diam, with clamp connections; inflated cells abundant, in terminal chains, globose to broadly elliptic, up to 63 x 63 µm, randomly distributed; remnants on basal bulb and pileus very similar. STIPE TRAMA: mostly inflated cells, fusiform to clavate, terminal, up to 315 x 31 µm, most smaller, longitudinally oriented; filamentous hyphae sparse, undifferentiated, sparsely branched, 2-6 µm diam, with clamp connections. PARTIAL VEIL: filamentous hyphae moderately abundant, undifferentiated, moderately branched, 1.5-5.5 µm diam, with clamp connections; inflated cells terminal, mostly broadly elliptic to fusiform, up to 47 x 18 µm.

BASIDIOSPORES: 10.2-11.7 x 7.0-7.8 µm ($\underline{E}$ = 1.31-1.56; $\underline{E}^m$ = 1.49), elliptic, adaxially flattened, thin walled, hyaline, nonamyloid; white in deposit; contents guttulate, apiculus sublateral, cylindric.

Habitat and distribution: terrestrial, solitary to gregarious, under loblolly pine and mixed hardwoods, to date known only from Alabama.

Collections examined: Talladega, Alabama: cabin property of Dr. John Farmer, Lay Lake, 18. ix. 83, David T. Jenkins 1755(DTJ), holotype: cabin property of Dr. John Farmer, Lay Lake, 15. ix. 84, David T. Jenkins 2594(DTJ): cabin property of Dr. John Farmer, Lay Lake, 16. ix. 84, David T. Jenkins 2595(DTJ).

Discussion: *Amanita roseophylla* is assigned to subgenus *Amanita*, section *Amanita* (Corner & Bas, 1962) on the basis of the following characteristics: nonamyloid basidiospores, striate pileus margin, and a distinct basal bulb.

Amanita roseophylla is somewhat atypical of taxa in section *Amanita*. This is due to the presence of several features not usually found within this section. The pileus margin, which is characteristically distinctly striate in section *Amanita*, is only very slightly striate. This is due to the unusually thickened trama at the pileus margin. The basal bulb is marginate to submarginate, similar to those of *Amanita citrina* or *Amanita brunnescens* in section *Phalloidae*. Also, the presence of grayish volval material is rarely found within section *Amanita*. The most noticeably different characteristic, however, is the creamy-pink color of the lamellae. In the genus *Amanita* the lamellae are commonly white to cream, rarely having a slight tint of some other color. Within section *Amanita*, the intensity of this creamy-pink color in the lamellae of *Amanita roseophylla* is, therefore, quite distinctive and characteristic.

Within section *Amanita*, *Amanita roseophylla* appears to have no closely related taxon. The only taxa which regularly have a comparable pileus diameter are A. *farinosa* and A. *crenulata*. Neither have the same pileus color or the pinkish lamellae. *Amanita farinosa* has a grayish volva, but has a distinctly striated pileus margin. Generally, taxa in section *Amanita* do not have pilei with a color similar to A. *roseophylla*. Occasionally, however, certain specimens of the varieties of A. *pantherina* might approach this color.

Considering the unique combination of characters possessed by *Amanita roseophylla*, it is clearly distinctive within section *Amanita*.

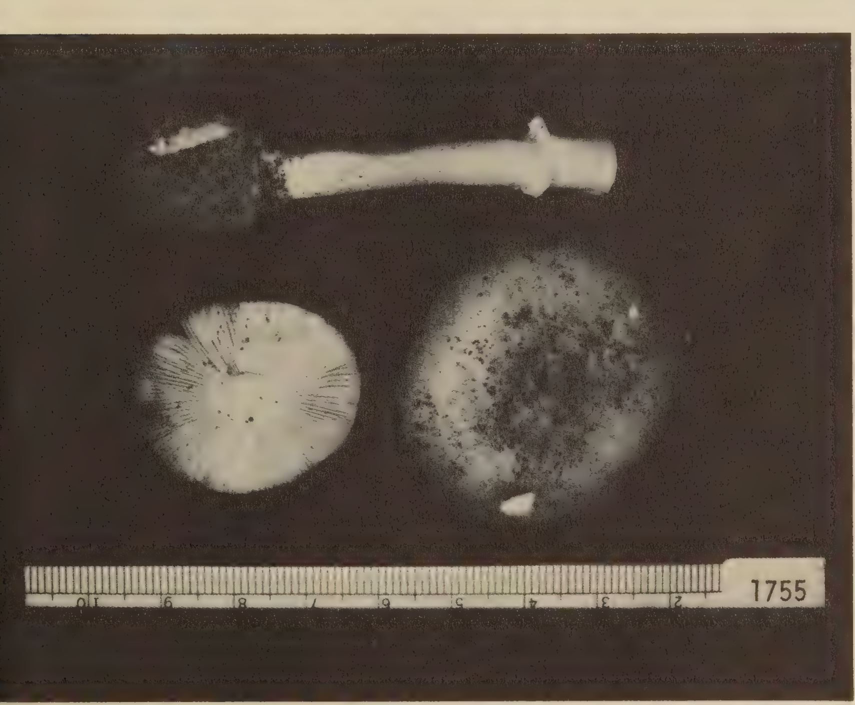

Fig. 1 *Amanita roseophylla* 1755 DTJ

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MYCOTAXON

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PIREX GENUS NOVA
(BASIDIOMYCETES, CORTICIACEAE)

by

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SUMMARY

The genus Pirex is described with Radulum concentricum Cke & Ellis as type. It is characterized by a dentate to semiporoid, chrome yellow basidiocarp reacting reddish with KOH and a dark brown trama and context. The type species is known only from the Pacific area of North America. Its culture characters are described.

In 1984 one of us (LR) collected in California and found in several localities a striking yellow, hydnoid and resupinate species. Professor R.L. Gilbertson, Univ. of Arizona, could immediately determine it to Radulum concentricum Cke. & Ellis which he knew well from his studies on resupinate hydnoid basidiomycetes in North America (Gilbertson 1963, 1964).

When another of us (KH) saw the basidiocarps from California he realized that it already was in culture in Göteborg from a collection made by another of us (NH) in British Columbia in 1982. Radulum concentricum has a unique combination of characteres with a hydnoid to subporoid hymenophore in a warm chrome yellow colour which reacts with a red colour in KOH, and a dark brown cottony trama and subiculum. We have not been able to find a proper genus for this species, and thus, a new genus is proposed.

Pirex Hjortst. & Ryv. gen. nov.
Etymology: anagram of Irpex Fr. Gender: m.
Fructificatio resupinata, effusa, in typo quasi 2-5 mm crassa; hymenium plus minus ceraceum, irregulariter obtuse dentatum vel subporoideum. Systema hyphale monomiticum, hyphis omnibus fibulatis; subiculum distinctum, tomentosum, fuscum; hyphis basilibus crassiusculis, ramosis, intertextis, brunneolis, hyphis ceteris plus minus hyalinis, leviter oleosis; cystidia absentia, in hymenio

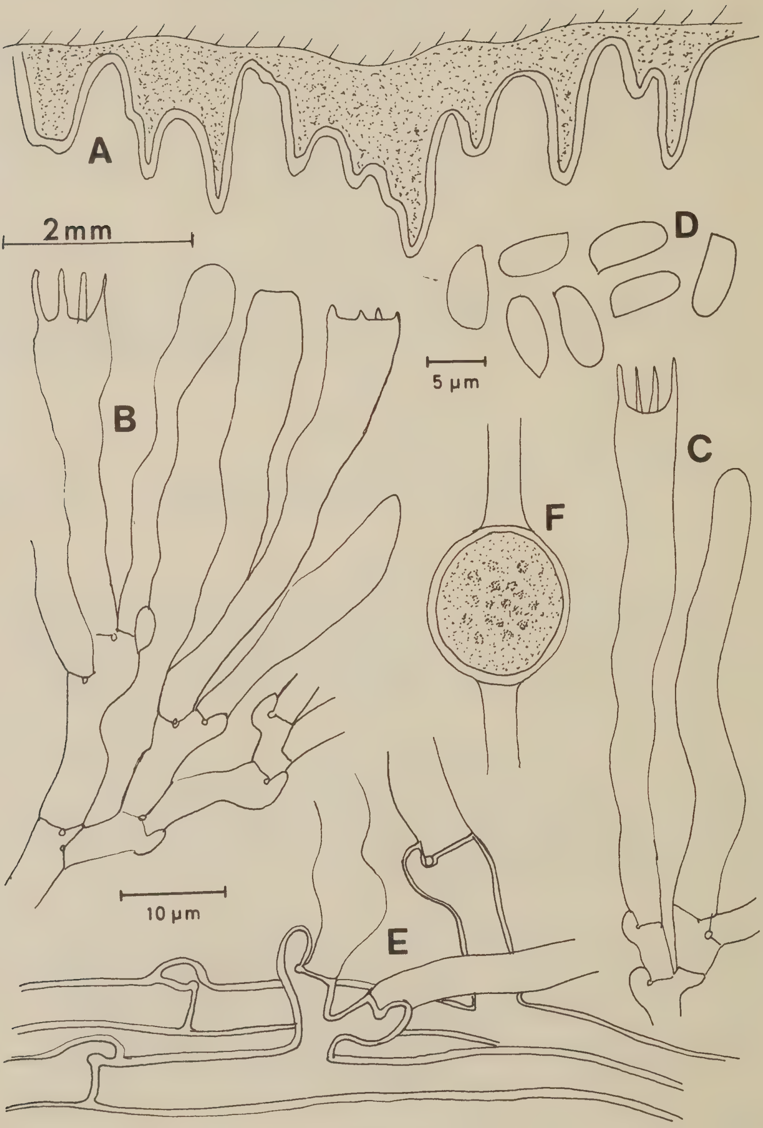

Fig. 1. *Pirex concentricus* A) Section through basidiocarp. B) Basidia. C) Basidium. D) Spores. E) Hyphae from the coloured context. F) Chlamydospore with partly visible nuclei. A-E, from the holotype, F, from Hallenberg 7095.

hyphae cystidioideae dispositae; basidia clavata, leviter constricta, 4 sterigmatibus; sporis ellipsoidibus vel anguste ellipsoidibus, tenuitunicatis, levibus (statura mediocris), neque amolyoidibus et cyanophilis neque dextrinoidibus.

Typus generis: Radulum concentricum Cooke & Ellis

Basidiocarp resupinate, effuse, moderately thick, in the type-specimen approximately 2-5 mm, hymenium subceraceus, odontoid to hydnoid or subporoid. Hyphal system monomitic, with clamps on all hyphae. Subiculum distinct, cottony, brown, hyphae moderately thick-walled, ramified and irregularly interwoven, yellowish brown, other hyphae more or less hyaline, with oily contents in the protoplasm. Cystidia absent but hyphal elements (cystidioles) may occur in the hymenium. Basidia typically clavate, slightly constricted and basally narrowing, with 4 sterigmata and a basal clamp. Spores ellipsoid to narrowly ellipsoid, thin-walled, smoooth, moderately sized (6-9 um), acyanophilous, non-amyloid, non-dextrinoid.

Remarks. Pirex is well characterized by its conspicuous brown subiculum, which is very striking in the central part of the aculei. Of further important diagnostic value are the hymenial configuration, the club-shaped basidia, and the thin-walled, smooth spores. The reddish colour change in KOH (which in the type is very slight, see Gilbertson, 1963) is very obvious in fresh specimens, but also in well-developed and properly dried specimens. Microscopically, the generic type is somewhat like Cylindrobasidium evolvens (Fr.) Jülich, especially by its oil-rich hyphae and the shape of the basidia. For further information of Radulum concentricum, see Gilbertson 1963 and 1964.

Pirex concentricus (Cooke & Ellis) Hjortst. & Ryv. comb. nov.
Basionym: Radulum concentricum Cooke & Ellis, Grevillea 14:13, 1885.
Synonym: Irpex owensii Lloyd, Myc. Writings, 5:616, 1916.
- Radulum owensii (Lloyd) Lloyd, Myc. Writings, 5:10, 1917, fide Gilbertson 1964.
Holotypus: Coos River, Oregon, on dead Myrtle. W.S. Carpenter, distributed by Ellis and Everhart in North American Fungi No. 1710. (NY).!

Basidiocarp adnate, effused, up to 5 mm thick, sordid to chrome yellow or light brown when dry, odontioid or hydnoid with conical or more commonly flattened aculei, usually 2-4 mm long, often sub-poroid. Now and then the pores are arranged in concentric zones. The trama and subiculum is dark brown with a loose texture strongly in contrast to the yellow and ceraceous hymenium. In well developed specimens there will be a strong reddish reaction in KOH. The hyphal system is monomitic and all hyphae with clamps.
In cross-section the basidiocarp is composed of two layers: 1) the subiculum which is snuff-brown and conspicuous next to the substratum and in the central part of the aculei, consisting of loosely interwoven and moderately thick-walled hyphae, 3.5-4.5(-5) um wide; 2) the more or less dense and bright-coloured subhymenium, usually defined by a darker line, hyphae sybhyaline or hyaline, generally arranged vertically, 2.5-3.5(-4) um wide. Cystidia lacking

but sometimes protruding hyphoid elements are present. Basidia narrowly clavate, 40-50x5-6 um, normally with 4 sterigmata and a basal clamp. Spores ellipsoid or more commonly narrowly ellipsoid, basally straight or slightly convex, smooth, thin-walled, (6-)7-7.5(-8.5)x3-3.5(-4) um, with oily inclusions in the protoplasm. The species has been noted from *Vinca*, *Quercus* and *Alnus*, and we have seen specimens from British Columbia (Canada), Washington, Oregon and California (USA). In South California *P. concentricus* is very common and found in almost any oak-forest with some dead logs on the ground. We have not seen it reported outside the area given above and seemingly the species has a distinct distribution along the Pacific coast of North America.

Culture characters

Methods. Drop-tests for extra-cellular oxidases follow Marr's directions (1979); culture codes are from Nobles (1965) with emendations by Boidin and Lanquetin (1983); nuclear staining has been made with Giemsa according to Boidin (1958). Common malt agar has been used as medium.

Culture characters. Growth rapid, plates covered in two weeks. Aerial mycelium absent, advancing zone even, appressed. Hyphae with clamps at most septa, thin- to slightly thick-walled, 1,5-7 um wide, hyaline, the wider hyphae rather short-celled, sometimes with constrictions; content partly light-refracting (in phase contrast). Chlamydospores present, globose, 12-21 um in diam., thick-walled, with ligh-refracting content, intercalary or terminally formed. Reverse brownish.

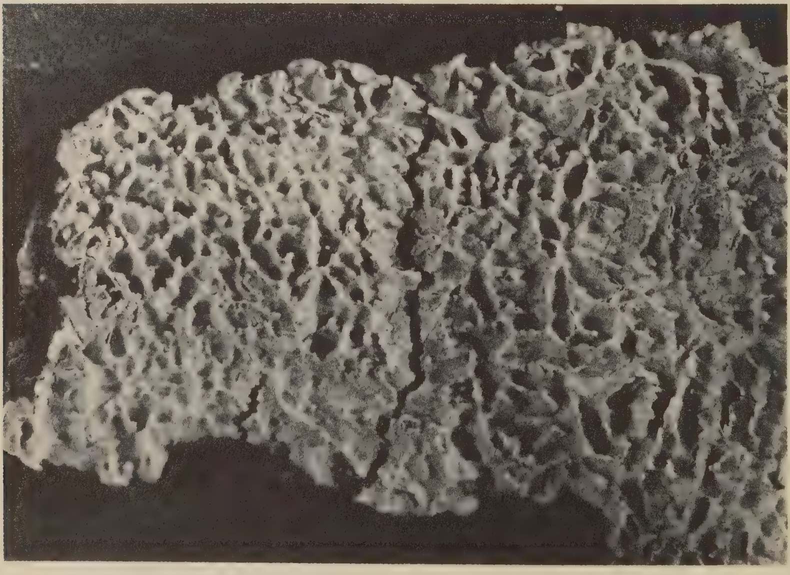

Fig. 2. Basidiocarp of *Pirex concentricus* showing the irregular hymenophore. Coll. Ryvarden 21895.

Culture code:
1. 3i. 25. 34. 36. 39. 42. 54. 58. 63.
Oxidase reactions: All tests were negative (Syringaldazine, Gum Guaiac, Guaiacol, 1-Naphtol, p-Cresol, L-Tyrosine).
Polarity: 3 single-spore (SS) cultures were isolated and matings between them were made but no clamps were formed in these confrontations. In di-mon matings between available SS-cultures and the polyspore (PS) culture, clamps were formed on the haploid side in all combinations. Thus, P. concentricus is regarded as heterothallic, but type of polarity unknown.
Cytology: SS-mycelium with 1-6 nuclei/cell, in PS-mycelium most cells dicaryotic, a few cells with 3-4 nuclei, chlamydospores with 5-20 nuclei or more. Nuclear behavior heterocytic (Boidin, Lanquetin, 1984) with irregularities.

Acknowledgements.
Professor R.L. Gilbertson, Univ. of California is thanked for his generous help both with the initial identification and for his suggestions to improvements in the manuscript.

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STUDIES ON CHINESE ASCOMYCETES.
2. Sinodidymella verrucosa.

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ABSTRACT

Amphididymella Petrak is a synonym of Acrocordia Massal. The type species **Amphididymella adeana** Petrak is **Acrocordia gemmata** (Ach.) Massal. **Amphididymella verrucosa** Petrak is assigned to the new genus Sinodidymella J.-z. Yue & O. Eriksson (Dothideales).

INTRODUCTION

Our studies of type material of the generic monotype **Amphididymella adeana** Petrak and of **A. verrucosa** Petrak revealed that these species are not congeneric and that a new genus has to be established for the latter species.

MATERIALS AND METHODS

Ascomata were embedded in LKB 2218-500 Historesin, a glycol methacrylate (GMA) suitable for making semi-thin sections with glass knives. According to the instructions from the manufacturer, any fixative for light microscopy and most conventionally used histological stains should be compatible with Historesin. In order to get optimal results for fungus material we made comparative studies of three different fixatives and ten stains with fresh material of 4 different fungi, namely **Teichospora sp.** (Sweden, Västerbotten, Umeå, Hamrinsberget, on **Salix caprea**, 6.XI.1984, leg. et det. Yue Jing-zhu & Ove Eriksson, UME 29053), **Tubercularia vulgaris** Tode (ditto, on **Prunus padus**, UME 29054), **Cytidia salicina** (Fr.) Burt (ditto, on **Salix sp.** UME 29055), and **Phaeomarasmius erinaceus** (Fr.) Kühner

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(ditto, on **Alnus incana**, UME 29056). The samples were fixed in 5% glutaraldehyde (GA), 5% formaldehyde (FA), or 1% tannic acid for 4 hrs. After dehydration in progressively increasing concentrations of alcohol, they were treated with LKB infiltration solution, and then embedded in LKB embedding medium (infiltration solution + hardener). Semi-thin sections were cut with glass knives in an LKB Histo-Range Microtome and then stained with one of the following stains: Toluidine Blue (C.I. No. 52040), Brilliant Cresyl Blue (C.I. No. 51010), Aniline Blue, Cotton Blue, Congo Red, Safranin, Chlorazol Black, Carmine (C.I. No. 75470), Janus Green (C.I. No. 11050), Sulfo-vanillin (for C.I. numbers of the other stains see Lillie 1977). We found that GA was the best of the three fixatives. Materials fixed with GA could easily be cut into semi-thin sections, which stretched readily in water, while samples fixed with FA or TA were more easily broken or wrinkeled in water. Sections stained with Toluidine Blue furnished high contrast, irrespective of the fixative, and the embedding plastic remained hyaline. Thus, fungus and host tissue were clearly discernible. Staining with Brilliant Cresyl Blue and Aniline Blue also gave satisfactory results. The rest of the stains showed low contrast, and sections were barely stained unless staining was prolonged to 20-30 minutes. Moreover, the embedding plastic was also stained. The semi-thin sections of **Sinodidymella verrucosa** were fixed with GA and stained with Toluidine Blue.

TYPE MATERIAL OF AMPHIDIDYMELLA ADEANA

Amphididymella adeana Petrak (1928: 94).
TYPE: Spain, Canary Islands, Tenerife, on **Pyrus communis**, V. 1926, leg. A. Ade (coll. orig.: W 10061, W 17243, and W 26874).

We have examined the material in the three envelopes having labels with the same collection data and stated to contain the type of **Amphididymella adeana**. One of them (W 17243) contains the original handwritten label and 5 fragments of bark with an ascomycete. The other two envelopes (W 10061 and W 26874) contain 4 pieces in all, ca. 4-5 cm long and 4-7 mm wide, of partly decorticated twigs with dark-coloured ascomata.

W. 17243. The fungus on the bark agrees well with Petrak's description of **A. adeana** and should be considered holotype. The ascomata are rounded with thin and pale walls in the lower half, but with thicker and darker wall in the upper part (more or less distinct clypeus). The hamathecium consists of thin, anastomosing paraphysoids in a rather firm gel, cylindrical asci with uniseriate, ellipsoidal, 1-septate, hyaline ascospores, which are enclosed in a thin gelatinous sheath (perispore). However, Petrak did not observe the meniscus capping the ocular chamber in the ascus. He also failed to notice that the epispore layer in the ascospores is rough. This fungus agrees in every respect with the endophloedal lichen **Acrocordia gemmata** (Ach.) Massal. (cf. Swinscow 1970: 223; Eriksson 1981: 22). Especially characteristic to the genus Acrocordia are the semiglobose meniscus and the hyalodidymous spores. - These observations imply that Amphididymella becomes a synonym of Acrocordia Massal.

W 10061 and W 26874. The two collections on decorticated twigs do not contain **Amphididymella adeana** (= **Acrocordia gemmata**), but a unitunicate pyrenomycete with an I+ blue ring in the ascus top and 1(-3)-septate brownish ascospores. This is an **Amphisphaeria** species. The genus contains ca. 80 species (Hawksworth et al. 1983: 14) and is in need of revision. Several species have been described on members of the Rosaceae, e.g. **A. pomacearum** Marcich on **Malus domestica** and **Pyrus communis**, and **A. pyrina** Frolov on **P. communis** (see Index of Fungi, Vol. 3: 321, Jan. 1966, and 3: 431, Jan. 1968). It is obvious that Petrak never examined the ascomata on the twigs as they resemble ascomata on the bark, otherwise he would have mentioned an **Amphisphaeria sp.** on **Pyrus communis** in his paper.

TYPE MATERIAL OF AMPHIDIDYMELLA VERRUCOSA

Sinodidymella J.-z. Yue & O. Eriksson, gen. nov.

Pseudothecia dispersa vel stipata, tunc ± connata, primum omnino innata, postea ± erumpentia, subglobosa, pseudostiolata, periphysata; paries ascomatum in parte exteriore cellulis crasse tunicatis brunneis, in parte interiore hyalinis constitutus. Pseudostiolum tumulis radialibus circumdatum

Asci numerosi, subcylindrici, bitunicati, 8-spori, - paraphysoidibus circumdati.

Ascosporae fusoideae, 1-septatae, medio leniter constrictae, hyalinae.

TYPUS: S. verrucosa (Petrak) J.-z. Yue & O. Eriksson.

Sinodidymella verrucosa (Petrak) J.-z. Yue & O. Eriksson

Basionym: **Amphididymella verrucosa** Petrak in Acta Horti Gothob. 17: 129 (1947).

Ascomata scattered or ± densely gregarious, immersed at

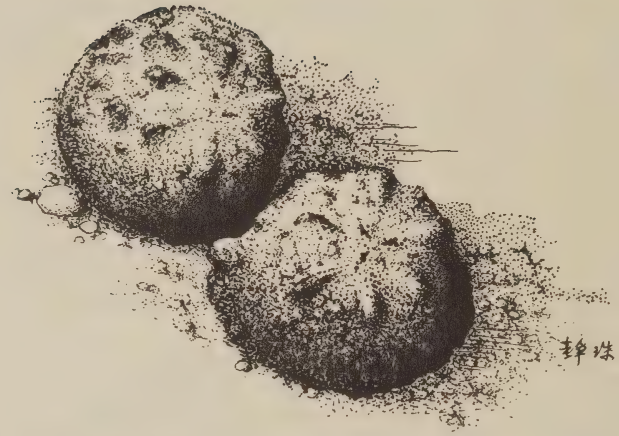

Fig. 1. **Sinodidymella verrucosa**, two ascomata. Magn.: x35.

first, then erumpent and finally almost superficial, subglobose, ca. 1 mm across, with 3-6 radial ridges around the pseudostiolar region, black; ascomal wall ca. 60 µm and of small hyaline cells in basal parts of ascomata, thicker and up to ca 150 µm in erumpent parts of ascomata and here with an outer pseudostromatic layer of dark brown fungus cells and remnants of host cells, and an inner eustromatic layer of hyaline fungus cells, the outermost of which are scleroplectenchymatous (esp. in the ridges).

Central cavity ca. 700 µm across and ca. 575 µm high, hollow in dry ascomata; hamathecium of periphyses in the pseudostiole, and of anastomosing paraphysoids in hymenial gel, ca. 1.5-3 µm wide, at the base ca. 4.5-6 µm and connected with short, barrel-shaped cells.

Asci numerous, ca. 150 x 15 µm, subcylindrical, rather short-stalked, bitunicate, with thin ectotunica capped by a gelatinous triangular corona (Congo Red), and rather thin endotunica with a rather low and broad ocular chamber, but no ring structure or meniscus, 8-spored.

Ascospores ca. 19-21 x 7.5-8.5 µm, fusiform, straight or a little inequilateral, 1-septate, somewhat constricted at septum, hyaline, without distinct perispore, smooth, each cell with a large globule.

TYPE: China, Kansu Prov., between Scharakuto and Kweite, on rotten stems of **Salsola gemmascens**, 25.VII.1935, leg. G. Fenzel 2400 (W 16366).

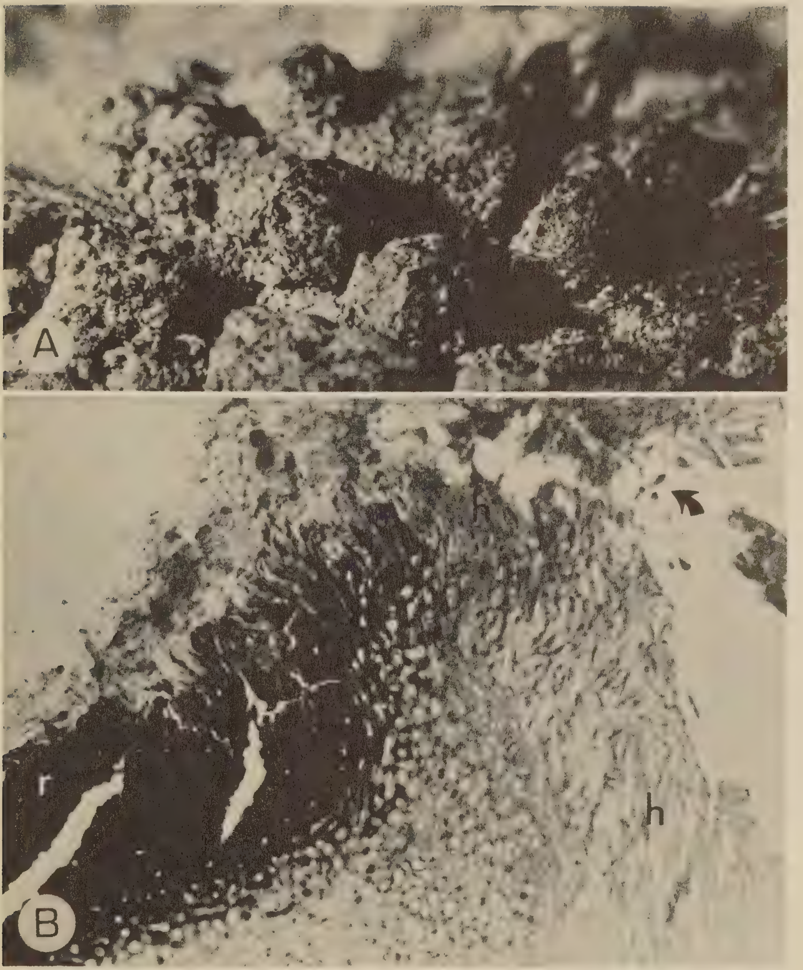

Fig. 2. **Sinodidymella verrucosa. A.** Ascomata. **B.** Section through pseudostiolar region of ascoma. Note the pseudostiole (arrow) partly filled with periphyses, the dark-coloured tissue in the ridge (r), the dark hyphae directed upwards near the pseudostiole, the hamathecium (h) of periphyses and paraphysoids. Cf. Fig. 3A.

The type material consists of three pieces of rotten wood of **Salsola gemmascens** with ascomata and two small fragments without. There are only 5 ascomata on the largest piece (22 x 5 mm), 16 on the next largest (17 x 8 mm), and several small, almost completely immersed and densely aggregated ascomata on the smallest piece (7 x 3 mm). The surfaces of the wood and the ascomata except for the ridges are covered with an amorphous, mealy substance of uncertain origin. In the microscope it seems to consist of fragments of plant tissue and small mineral particles. In sections also numerous bacteria are seen in this dust.

DISCUSSION

Amphididymella was described by Petrak in 1928, but in 1959 (p. 7) he regarded it as a synonym of Massarinula G. Lam. Bose (1961: 156) cited both these names as synonyms of Massarina Sacc. Müller & von Arx (1962: 294) did the same, and this classification has been accepted by later authors.

Our studies of the generic type **Amphididymella adeana** Petrak revealed that, in fact, it is a well-known pyrenolichen, for a long time known as **Arthopyrenia gemmata** (Ach.) Massal., but currently called **Acrocordia gemmata** (Ach.) Massal. Our studies of the Chinese **Amphididymella verrucosa** Petrak showed that it is non-lichenized and differs in several respects from **A. adeana,** and that it should not follow this species into Acrocordia. Nor can **A. verrucosa** be referred to Massarina due to the characteristic, radially arranged ridges around the pseudostiole. Such ridges are not known in Massarina. We have considered every ascomycete genus accepted by Eriksson in 1984 (pp. 15-52), but none of them accommodates this species. Therefore, we refer the Chinese fungus to a new genus as **Sinodidymella verrucosa** (Petrak) J.-z. Yue & O. Eriksson. Its position within Dothideales s. lat. is uncertain.

The ascomata are partly immersed in both species, but may be almost superficial in **S. verrucosa**. Very characteristic are the radially arranged warts around the pseudostiole in this species. The ascomal walls are somewhat similar in the two species. The immersed parts of the walls consist of hyaline cells, whereas the erumpent parts have an outer, dark brown layer containing remnants of host cells (i.e. it is pseudostromatic) and an inner hyaline layer. The walls of the host cells are more prominent in **A. gemmata** and the dark-celled pseudostroma forms a conical clypeus (involucrellum) that ends rather abruptly. The

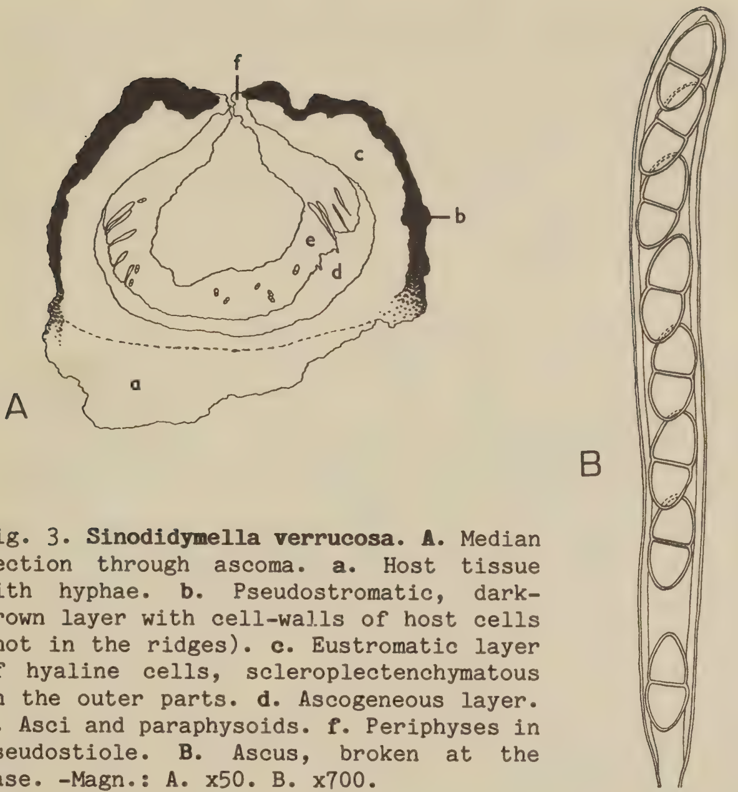

Fig. 3. **Sinodidymella verrucosa.** **A.** Median section through ascoma. **a.** Host tissue with hyphae. **b.** Pseudostromatic, dark-brown layer with cell-walls of host cells (not in the ridges). **c.** Eustromatic layer of hyaline cells, scleroplectenchymatous in the outer parts. **d.** Ascogeneous layer. **e.** Asci and paraphysoids. **f.** Periphyses in pseudostiole. **B.** Ascus, broken at the base. -Magn.: A. x50. B. x700.

reddish brown pigment is rather unevenly distributed and it may be difficult to see the cell walls sharply. **Sinodidymella verrucosa**, however, has thickwalled, dark brown, ±densely aggregated cells with distinctly visible lumina with smooth walls. The pseudostromal layer diminishes gradually towards the base. The centrum consists of paraphysoids and subcylindrical asci in hymenial gel in both species, but the asci of **S. verrucosa** do not have a semiglobose meniscus around the ocular chamber as in **A. gemmata**. The ascospores are hyaline and 1-septate in both species, but they are smooth and distinctly constricted in **S. verrucosa**, while rough (epispore) and non-constricted in **A. gemmata**.

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摘 要

Amphididymella Petrak 是 Acrocordia Massal 的同物异名. 模式种 Amphididymella adeana Petrak 实际为 Acrocordia gemmata (Ach.) Massal. 因此 Amphididymella verrucosa 被移入一新属—— Sinodidymella J.-z. Yue & O. Eriksson (Dothideales) (华隔孢壳属).

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NOTES ON PSEUDOPERONOSPORA

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ABSTRACT. Type studies proved that Pseudoperonospora aethionematis is conspecific with Peronospora parasitica, and that Pseudoperonospora elatostemae is better placed in Plasmopara. Examination of herbarium specimens an a review of the literature showed that Pseudoperonospora urticae is restricted to perennial Urticas and lacks oospores, whereas Peronospora debaryi is confined to Urtica urens and possesses resting organs. The species dealt with are illustrated.

The publication of the monograph on Pseudoperonospora by Waterhouse and Brothers (1981) raised some questions regarding the taxonomic positions of Pseudoperonospora aethionematis and Pseudoperonospora elatostemae, and also concerning the host range and the presence of oospores in Pseudoperonospora urticae. In an attempt to clarify these problems, the type specimens of the first two taxa were located and examined, and the literature records concerning the hosts and oospores of Urtica downy mildews were checked against the available herbarium material. In the following Pseudoperonospora and Urtica are abbreviated Ps. and U., respectively, and the herbaria are cited according to Holmgren et al. (1981).

On **Pseudoperonospora aethionematis**

Ps. aethionematis (Simonyan) Waterhouse - Mycol. Pap. 148: 18. 1981 was based on a fungus described by Simonyan (1976) under two different names. The description in Russian was headed Peronoplasmopara aethionematis, a name which was also used for the illustration and in the discussion following the Latin description. The Latin description bears another name, *Peronospora aethionematis*, a binomial which is also mentioned in the abstract. Being alternative names, neither is validly published (Art. 34.4 ICBN). Nevertheless, it seems that the author had in mind *Pseudoperonospora* (= *Peronoplasmopara*) rather than *Peronospora*. This is particularly evident from the description of 'conidia' with apical papillae. Moreover, in a later publication, Simonyan (1981) mentioned this fungus four times (pp. 24, 93, 133 and 200) under *Peronoplasmopara*. Waterhouse based her decision on the description and illustration presented by Simonyan.

The examination of the type, deposited in herb. EREN and obtained through the courtesy of the LE herbarium, shows without doubt (Fig. 1) that this fungus is conspecific with *Peronospora parasitica* (Pers.: Fr.) Fr., s.l., the common downy mildew of Brassicaceae. The so called papillae are

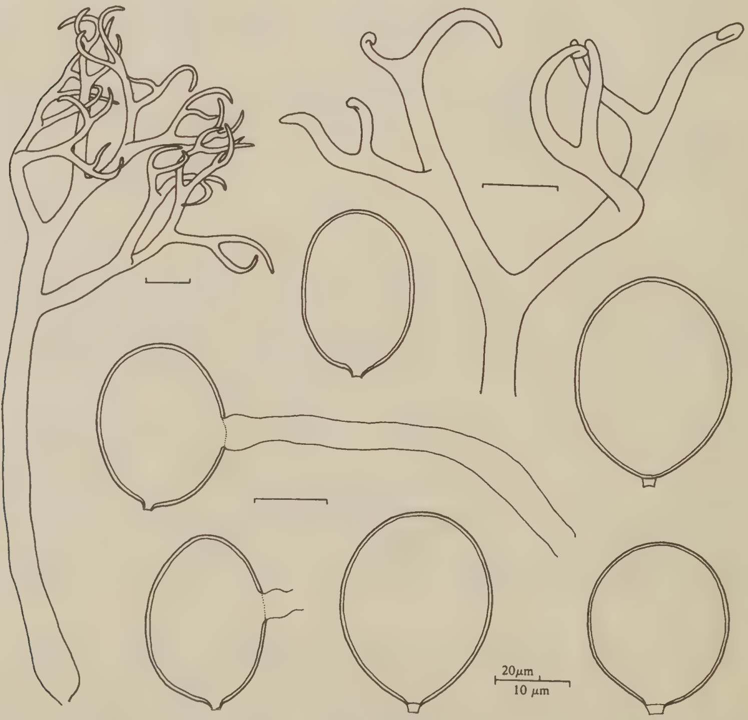

Fig. 1. *Peronospora parasitica*. From the type of *Peronoplasmopara aethionematis*.

actually the pedicells that are present in most of the conidia. The type specimen also shows some typically *Peronospora* germinating conidia.

On **Pseudoperonospora elatostemae**

Ps. elatostemae (Togashi & Onuma) Hoerner - J. Wash. Acad. Sci. 30: 134. 1940 was listed by Waterhouse and Brothers (1981) among the excluded species. They could not examine the type, and considered inadequate the descriptions provided under *Peronoplasmopara* by Togashi and Onuma (1934) and under *Plasmopara* by Ito and Tokunaga (1935). Consequently, they expressed doubts about the generic position of this fungus.

However, the type specimen was detected in herb. SAPA and the illustration provided here in Fig. 2 shows that it is a typical *Plasmopara*.

The hosts and the presence of oospores in **Pseudoperonospora urticae**

The binomial *Peronospora urticae* (Lib. ex Berk.) Casp., usually cited '(Lib.) de Bary' or 'de Bary', was used for the downy mildew of *Urtica* species until Salmon and Ware (1929) demonstrated that two fungi are actually involved, namely *Ps. urticae* (Lib. ex Berk.) Salmon & Ware, parasitic on *U. dioica* L. and *U. urens* L., and *Peronospora debaryi* Salmon & Ware, parasitic on *U. urens*. Salmon and Ware also described oospores in both species.

During a study of Romanian *Peronosporales* (Constantinescu and Negrean 1983b), some fresh collections and numerous herbarium specimens of *Urtica* were examined. With one exception, when *Ps. urticae* was found on *U. kioviensis* Rogow, *U. urens* was parasitized by *Peronospora debaryi*, and *U. dioica* by *Ps. urticae*. In some specimens of *Peronospora debaryi* oospores were also present, but never in *Ps. urticae*. Further studies of herbarium material from other sources revealed the same apparently narrow specialization of these two fungi, as well as the lack of oospores in *Ps. urticae*.

As these findings were at variance with the conclusions drawn by Salmon and Ware (1925, 1929), and with the recent study of *Pseudoperonospora* (Waterhouse and Brothers 1981), an investigation of both literature records and preserved specimens was undertaken.

The hosts. Following the work of Salmon and Ware (1929), Viennot-Bourgin (1931), Gustavsson (1959) and Jörstad (1964) pointed out the morphologically distinctive features and/or the host specialization of these two fungi. In relatively recent lists or floras in which both fungi are mentioned (Ciferri and Camera 1963; Doppelbaur et al. 1965; Põldmaa 1967; Kochman and Majewski 1970; Järva and Parmasto 1980), *U. dioica* is the only host indicated for *Ps. urticae*.

Both *U. dioica* and *U. urens* have been cited as hosts for *Ps. urticae* not only by Salmon and Ware (1929), but also by

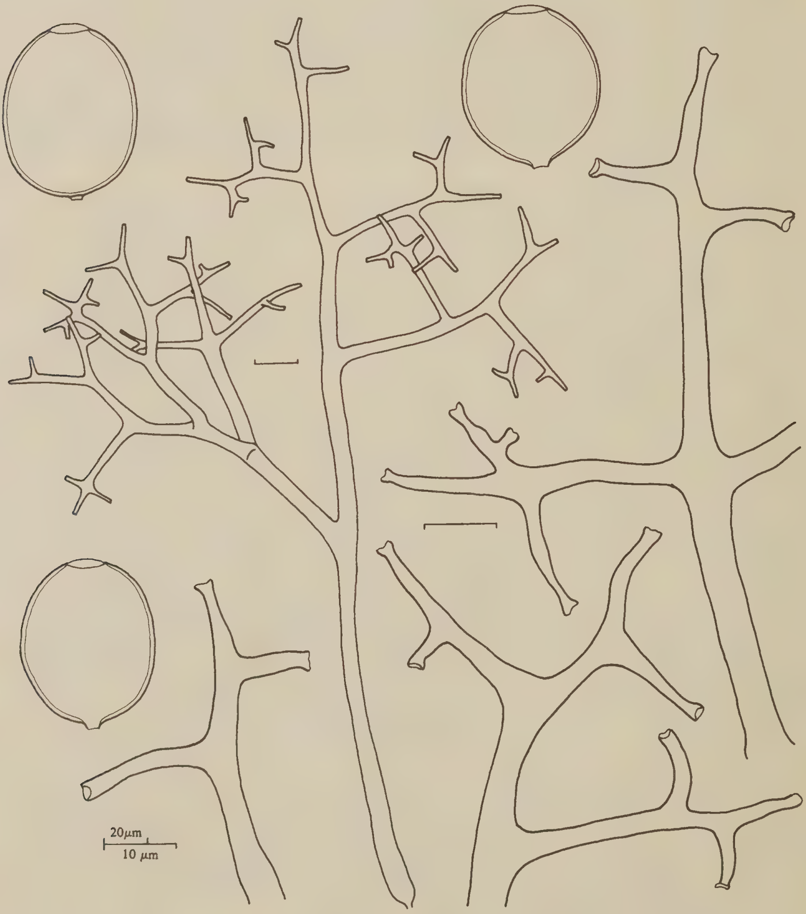

Fig. 2. *Plasmopara elatostemae*. From the type of *Peronoplasmopara elatostemae*.

Yachevskij and Yachevksij (1931), Viennot-Bourgin (1956), Săvulescu and Săvulescu (1951, 1964), Ul'iyanishchev (1967), Osipyan (1968) and Waterhouse and Brothers (1981). *U. urens* alone is mentioned as host by Naumov (1954), who considers the presence of *Ps. urticae* on *U. dioica* in the USSR doubtful, and by Vanev and Dimitrova (1979). Câmara (1936) recorded '*Peronospora urticae*' on *U. urens* from Portugal. Another annual nettle, *U. dubia* Forsskål (= *U.membranacea* Poiret), was reported by Viennot-Bourgin (1956) and Câmara and Oliveira (1944), the latter authors using the binomial *Peronospora urticae* (Lib.) de Bary for the fungus.

The attempts to trace and examine the specimens of *Ps. urticae* on other hosts than *U. dioica*, mentioned by the above cited authors, gave the following results:

The material of Salmon and Ware is not deposited at K or IMI, and it was apparently lost when Wye College herbarium was discarded (J.W. Mansfield, in litt.). The *U. urens* specimens cited by Yachevskij and Yachevskij (1931), Naumov (1954), Ul'iyanishchev (1967) and Osipian (1968) could not be located at the LE, LEP, BAK or EREN herbaria. The specimens cited by Săvulescu and Săvulescu (1951, 1964), examined at BUCM, and one specimen (IMI 61037a) cited by Waterhouse and Brothers (1981), proved indeed to be *U. urens*, but harbouring *Peronospora debaryi*. Another specimen of *U. urens* cited by the latter authors (IMI 50259) only contains oospores that are indinstinguishable from resting organs of *Peronospora debaryi*. The record of Vanev and Dimitrova was checked at our request and corrected to *Peronospora debaryi* (E. Dimitrova, in litt.). Viennot-Bourgin (1956) did not examine herbarium specimens but cited the hosts of *Ps. urticae* from literature sources (J. Mouchacca, in litt.). The specimen of *U. urens* cited by Câmara (1936) is deposited at LISVA, but could not be obtained as 'it is degraded' (Maria Eugenia P. da Costa, in litt.). According to Maria T. Lucas (in litt.), no voucher specimen is extant for the record of '*Peronospora urticae*' on *U. dubia* quoted by Câmara and Oliveira (1944).

The oospores. The resting organs of *Urtica* downy mildews were first described by de Bary (1863) as 'oospores mediocres, episporio sordide fusco'. The host, *U. urens*, and the conidia with obtuse apex, clearly indicate *Peronospora debaryi*. Karsten (1879) gave the same host and description, the latter obviously copied from de Bary. Schröter (1886), Berlese and De Toni (1888) and Fischer (1892) added no further details to de Bary's description, but mentioned both *U. dioica* and *U. urens* as hosts. More complete descriptions were provided by Berlese (1898, 1902) and Yachevskij (1901), but it is clear from the accompanying illustrations of conidiophores and conidia that Peronospora debaryi was involved. Consequently, it seems that prior to Salmon and Ware (1925), the records of oospores in Urtica downy mildews were based on specimens of U. urens parasitized by Peronospora debaryi.

Salmon and Ware (1925) have described (16-)29-30(-38) µm diam oospores in Ps. urticae parasitic on U. dioica. Curiously enough, they found no oospores in the few collections of U. urens examined. Blattny (1927), cited by Salmon and Ware (1929), apparently also described oospores in U. dioica, but his material could not be located in Czechoslovakian herbaria. Subsequent authors (Yachevskij and Yachevskij 1931; Săvulescu and Săvulescu 1951; Osipian 1968; Ul'iyanishchev 1967; Kochman and Majewski 1970; Gaponenko 1972; Vasyagina et al. 1977; Waterhouse and Brothers 1981) did not find oospores themselves, but used the description given by Salmon and Ware (1929). All but Yachevskij and Yachevskij (1931) and Săvulescu and Săvulescu (1951), acknowledged the source. As previously mentioned, the material of Salmon and Ware is no longer available. However, they (Salmon and Ware 1929) noticed oospores in one specimen of U. dioica originating from Lille, France, collected by Desmazières and preserved in Berkeley's herbarium. This specimen is now at K; the host is U. dioica indeed, bearing Ps. urticae , but no oospores were detected.

Conclusions. The efforts to locate and examine specimens of Ps. urticae parasitic on other hosts than U. dioica and U. kioviensis remained fruitless. Similarly, no specimen of U. dioica containing oospores could be found. Consequently, there are serious doubts both about the presence of Ps. urticae outside U. dioica and U. kioviensis, and concerning the existence of resting organs in this fungus.

The collection of Ps. urticae on U. kioviensis (Constantinescu and Negrean 1983a), which is closely related to U. dioica and has even been considered a subspecies of the latter, seems to indicate that new hosts of this downy mildew may be found among the perennial Urticas.

A peculiar case is the record of a perennial Urtica, U. dioica L. subsp. gracilis (Ait.) Selander (= U. gracilis Ait.), as a host for Peronospora debaryi, the only collection of this fungus from North America (Shaw 1949). The specimens (MO 675767 and 67553), now at BPI, consist of four leaves on which a fungus broadly similar to Peronospora debaryi but having slightly narrower conidia is present. Professor Dennis W. Woodland was only able to confirm the host at the generic level, but stated that 'the

Table 1

Distinctive characters of Urtica downy mildews

	Ps. urticae	Peronospora debaryi
Sporophore branches	almost straight	mostly flexuous
Branchlets tip	round to subacute	mostly blunt
Dissemination organs	sporangia, poroid, papillate, mostly 25-30 x 17-19 µm	conidia, nonporoid mostly 26-29 x 20-24 µm
Oospore	unknown	aplerotic, globose, (22-)28-37(-42) µm
Known hosts	U. dioica, U. kioviensis	U. urens

leaves were somewhat atypical'. As there are certain doubts about the identity of both the host and the fungus, and as this collection is outside the distribution area of Peronospora debaryi, the possibility that these specimens belong to another fungus cannot be ruled out.

In an attempt to detect possible new hosts, the Urticas deposited at UPS were scrutinized. Only one collection of U. urens originating from Lybia and parasitized by Peronospora debaryi could be found among the 643 specimens belonging to 34 taxa examined.

Although the taxonomy of Urtica downy mildews was elucidated by Salmon and Ware (1929), confusion still persists in the differentiation of these two fungi. The indication of U. urens as host, and the presence of oospores in Ps. urticae, have been and still are particularly misleading. As their material was not preserved, a definite clarification of this problem seems unlikely.

The distinctive characters of Urtica downy mildews as found in the present study are summarized in Table 1 and depicted in Figs 3 and 4.

ACKNOWLEDGEMENTS. I am indebted to the directors and curators of BPI, BRA, EREN, IMI, K, LE, PRM, S, SAPA and UPS herbaria for the loan of specimens, to Professor Dennis W. Woodland for checking the identity of American Urtica species, to the persons mentioned in the text for providing information on the availability of specimens and/or checking some records, and to Professor Arne Gustavsson for reviewing the manuscript. Part of this work was supported by a grant from the Swedish Institute.

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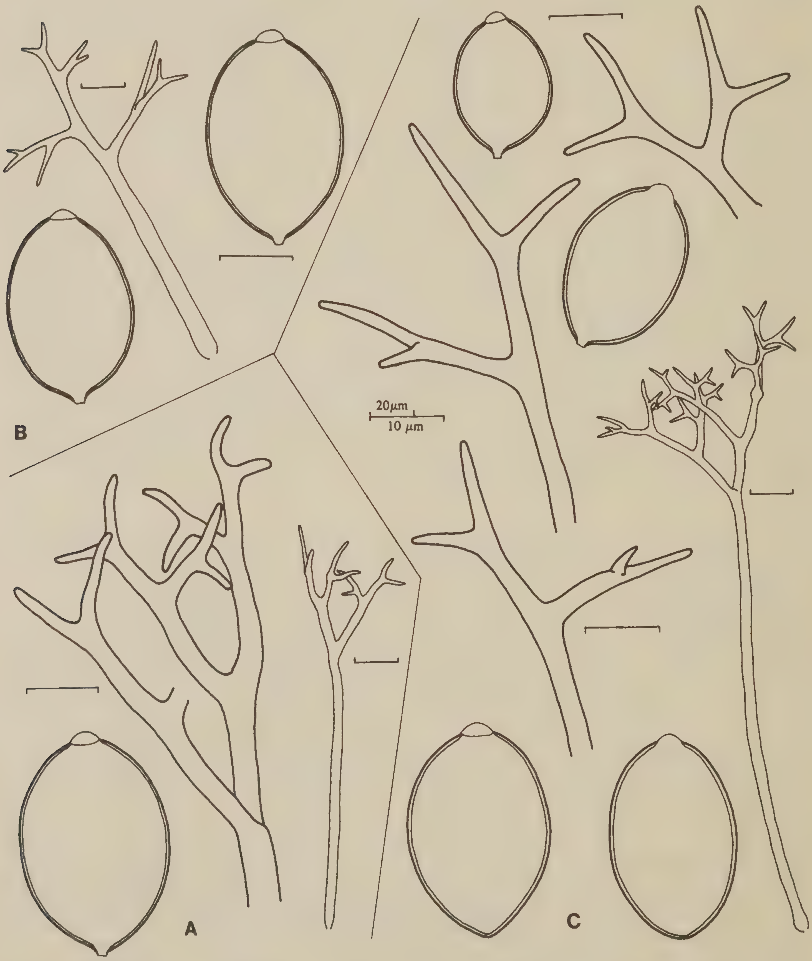

Fig. 3. Pseudoperonospora urticae. Sporangiophores and sporangia. A - from the holotype; B - from Berkeley herbarium in K (France, Lille, Desmazières); C - from BUCM 45990.

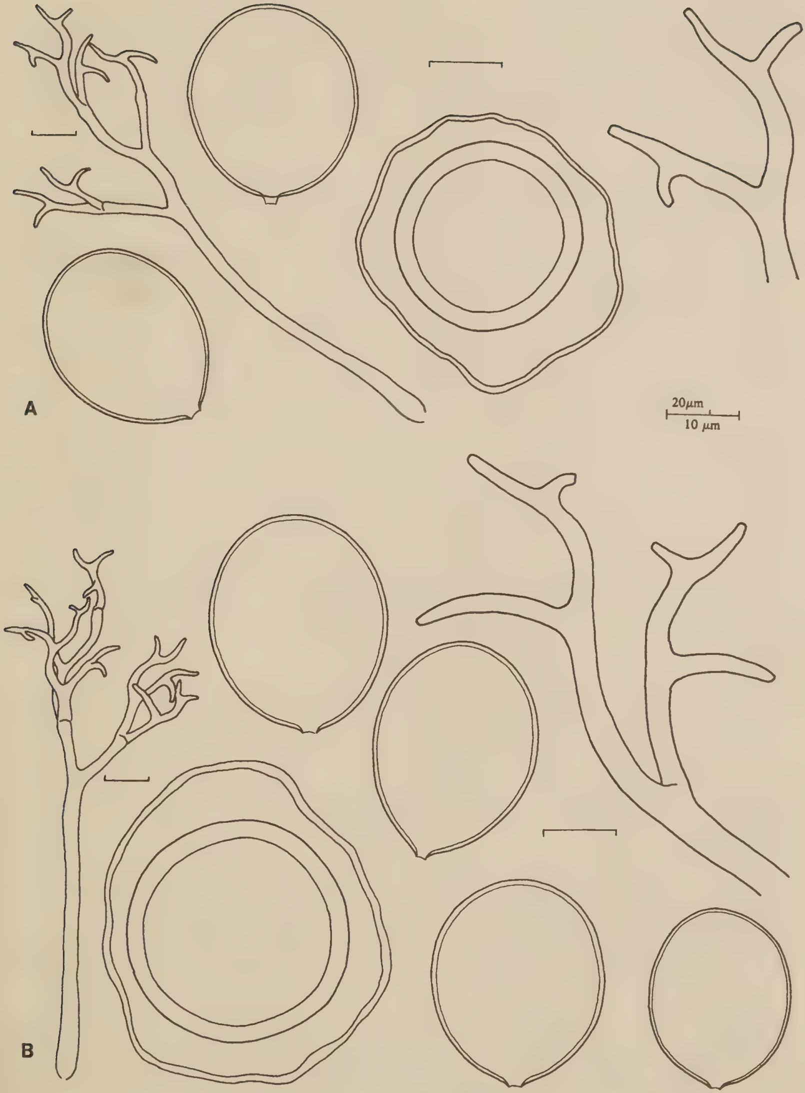

Fig. 4. Peronospora debaryi. Conidiophores, conidia and oospores. A - from Berkeley herbarium in K (England, King's Cliff, 25 June 1859); B - from BUCM 1488.

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NOTES ON HYPHOMYCETES. L.
TWO NEW SPECIES OF *SIROSPORIUM* FROM INDIA

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ABSTRACT

Two new foliicolous hyphomycete species, *Sirosporium morindinum* Kamal, B. Rai and Morgan-Jones and *Sirosporium rutacearum* Kamal, B. Rai and Morgan-Jones, are described and illustrated from collections made in Uttar Pradesh, India.

INTRODUCTION

The genus *Sirosporium* Bubák and Serebrianikow, established in 1912, remained monotypic until Ellis (1963) took it up for five additional species. The type species, *S. antenniforme* (Berk. and Curt.) Bubák and Serebrianikow, was originally classified in *Macrosporium* Fries and had also been described under the name *Gyroceras divergens* Peck. Those added by Ellis were previously classified in the diverse genera *Cercospora* Fres., *Clasterosporium* Schw., *Gyroceras* Corda, *Helicoceras* Linder, *Helminthosporium* Link and *Monilia* Bon. Two new species were described in the genus by Ellis (1967) and Kapoor (1968). Ellis (1976) added four further taxa formerly classified in *Cercospora, Clasterosporium, Helminthosporium* and *Oreophylla* Cif., three under the authority of F.C. Deighton, bringing the total number of accepted species to twelve.

During studies on foliicolous dematiaceous Hyphomycetes collected in Uttar Pradesh, India, we have encountered several taxa belonging to *Sirosporium*. One, *S. indicum* Kamal, Rai and Morgan-Jones, has been treated in a previous publication in this series (Kamal *et al.*, 1984). In the present paper two further newly discovered species are described.

TAXONOMIC PART

Sirosporium morindinum sp. nov. (Figure 1)

Maculae hypogenae, primum parvae orbiculares, in aetate magnae et

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irregulares, fusco-olivaceo brunneae. Coloniae hypophyllae, parvae et orbiculares, demum coalescentes et areas magnas tegentes, fusco-olivaceo brunneae vel fuscobrunneae, effusae, byssoideae vel coactae. Mycelium plerumque superficiale, partim immersum, ex hyphis ramosis, septatis, repentibus, laevibus, subhyalinis vel pallide olivaceo-brunneis, 1.5-3.5µm crassis compositum. Stromata carentia. Conidiophora solitaria, macronemata, mononemata, ex hyphis superficialibus repentibus lateralia oriunda, erecta vel sub-erecta, rare procumbentia, simplicia vel ramosa, recta vel leviter flexuosa, cylindrica, laevia, septata, olivaceo-brunneae, e cicatricibus crassis obscuris geniculata, 14-138 X 3.5-5µm. Cellae conidiogenae monoblasticae vel polyblasticae, in conidiophoris incorporatae, indeterminatae, terminales, interdum intercalares, sympodiales, cum 1-3 cicatricibus. Conidia solitaria, sicca, acropleurogena, simplicia, laevia, obclavata fere cylindrica vel clavata, recta vel curvata, ad apices subacuta vel obtusa, ad bases obconicotruncata vel subrotundata, pallide brunnea vel olivaceo-brunnea, septis transversalibus 1-23 et interdum septis longitudinalibus 1-2 praedita, plerumque ad septa constricta, hilo incrassato, 13-127 X 4-7µm.

In foliis vivis Morindae tinctoriae var. tomentosae, North Gonda Forest Division, Tulsipur, Uttar Pradesh, India, September 1979, B. Rai, AUA, holotypus.

Spots hypogenous, at first small and orbicular, later becoming large and irregularly shaped, dark olivaceous brown to blackish brown. Colonies hypophyllous, initially rather restricted, with age coalescing and eventually covering relatively large areas of the leaf surface, effuse, dark olivaceous brown to blackish brown, cottony to felty. Mycelium mostly superficial, partly immersed, composed of branched, septate, repent, smooth, subhyaline to pale olivaceous brown, 1.5-3.5 µm wide hyphae. Stromata lacking. Conidiophores solitary, macronematous, mononematous, arising laterally from the superficial hyphae, erect or rarely somewhat procumbent, olivaceous brown to dark olivaceous brown, cylindrical, smooth, septate, bearing thick scars, 14-138 X 3.5-5µm. Conidiogenous cells monoblastic or polyblastic, incorporated in the conidiophores, indeterminate, terminal or sometimes intercalary, sympodial, bearing one to three scars; very rarely a monoblastic conidiogenous cell may be formed by lateral growth from an intercalary conidial cell. Conidia solitary, dry, acropleurogenous, simple or very rarely bearing a lateral extension giving rise to a daughter conidium, smooth, obclavate to almost cylindric or clavate, straight or somewhat curved, with subacute to obtuse apices and obconicotruncate to rounded at the base, pale brown to olivaceous brown, with 1-23 transverse and sometimes one or two longitudinal or oblique septa, more or less constricted at the septa, with a thickened hilum, 13-127 X 4-7 µm.

On living leaves of *Morinda tinctoria* Roxb., var. *tomentosa* Hook., [Rubiaceae]; India.

Collection examined: on *M. tinctoria* var. *tomentosa*, North Gonda Forest Division, Tulsipur, Uttar Pradesh, India, September 1979, B. Rai, AUA, IMI 234845, GPU (KR142), type.

Sirosporium morindinum bears a broad similarity to several other non-stromatic species of the genus, particularly *S. celtidis* (Biv.-

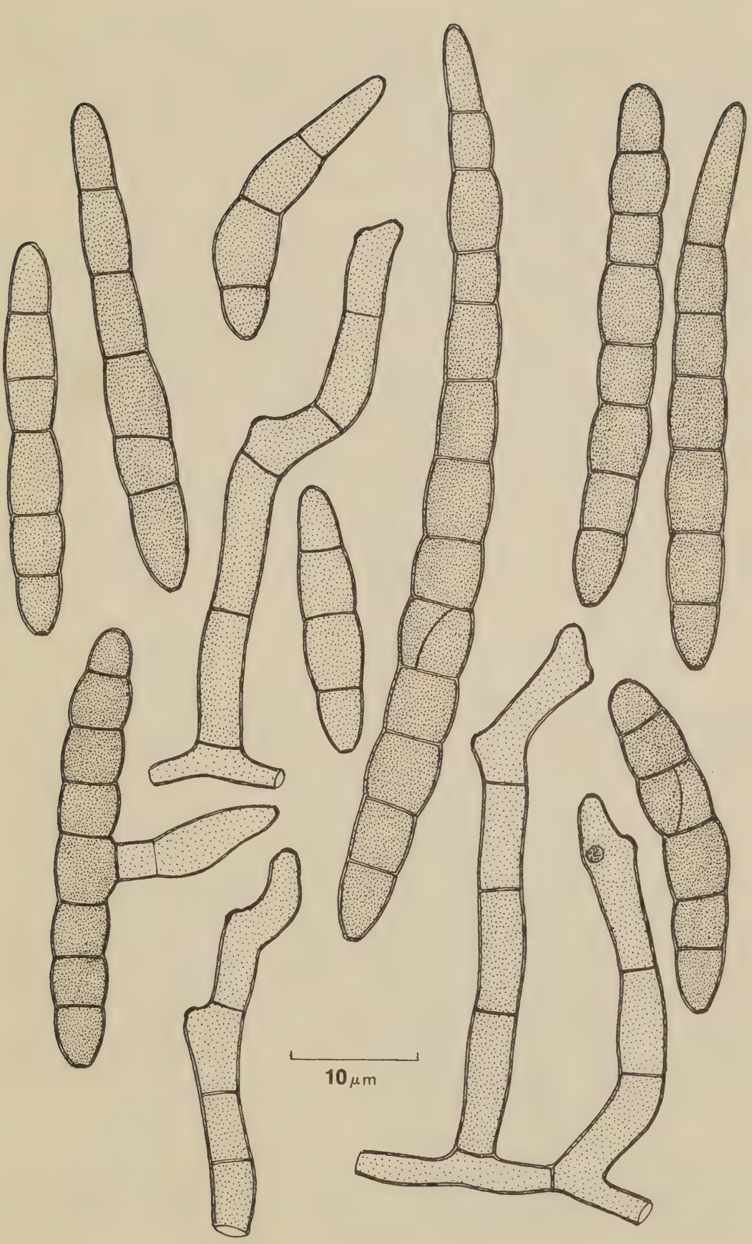

FIGURE 1. *Sirosporium morindinum*

Bernh. ex Sprengel) M.B. Ellis and *S. diffusum* (Heald and Wolf) Deighton. In the morphology of its conidia it most closely resembles the latter but differs from it by possession of lengthy conidiophores. In having occasional oblique or longitudinal conidial septae it bears similarity to the type species, *S. antenniforme*. It is unique among *Sirosporium* species in forming, rarely, secondary conidia.

Sirosporium rutacearum sp. nov. (Figure 2)

Maculae amphigenae, in forma et magnitudine variabiles, fuscoalutaceae. Coloniae hypophyllae, discretae vel demum coalescentes, fuscobrunneae vel nigellae, primum punctiformes deinde effusae et coactae. Mycelium partim superficiale et partim in substrato immersum, ex hyphis ramosis, septatis, levibus, subhyalinis, 1-3μm crassis compositum. Stromata partim superficialia, partim immersa, fuscobrunnea, pseudoparenchymatica, 25-115μm lata. Conidiophora fasciculata ex stromate quoque oriunda, macronemata, erecta, simplicia, recta vel flexuosa, cylindrica, laevia, septata, pallide vel mediobrunnea, cicatricibus, leniter incrassatis sed distinctis praedita, 14.5-83 X 4.5-8μm. Cellae conidiogenae monoblasticae vel polyblasticae, in conidiophoris incorporatae, indeterminatae, terminales, sympodiales, cum 1-3 cicatricibus. Conidia solitaria, rare catenata, sicca, acropleurogena, simplicia, cylindrica, recta vel leniter curvata, ad apices obtusa vel subacuta, ad bases plus minus obconico-truncata, medio vel fuscobrunnea, transverse 2-multiseptata, ad septa saepe constricta, levia vel verruculosa, 10-150 X 5.5-7μm.

In foliis vivis Clausenae pentaphyllae, West Baharaich Forest Division, Kakarha, Uttar Pradesh, India, February 1979, B. Rai, AUA, holotypus.

Spots amphigenous, somewhat irregular in shape and size, dark tan. Colonies hypophyllous, discrete or coalescing, punctiform, becoming effuse and felty, blackish brown. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, smooth, subhyaline, 1-3μm wide hyphae. Stromata partly superficial, partly immersed, initiated in a substomatal position, becoming well-developed and erumpent, dark brown, pseudoparenchymatous, composed of more or less isodiametric cells, 25-115μm wide. Conidiophores densely fasciculate, arising from the upper cells of the stromata, macronematous, more or less erect, unbranched, straight or slightly flexuous to somewhat geniculate, cylindrical, smooth, septate, pale to mid-brown, bearing conidial scars, 14.5-83 X 4.5-8μm. Conidiogenous cells monoblastic or polyblastic, incorporated in the conidiophores, indeterminate, terminal, sympodial, bearing 1-3 thin but distinct scars. Conidia solitary, very rarely producing a single secondary conidium, dry, acropleurogenous, simple, cylindrical, straight or slightly curved, obtuse or subacute at the apex, obconicotruncate at the base, mid to dark brown, with 1-many transverse septa, sometimes slightly constricted at the septa, smooth or verruculose, 10-150 X 5.5-7μm.

On living leaves of *Clausena pentaphylla* DC [Rutaceae]; India.

Collection examined: on *C. pentaphylla*, West Baharaich Forest Division, Kakarha, Uttar Pradesh, India, February 1979, B. Rai, AUA, IMI 237112, GPU (KR237), type.

Among stromatic species of *Sirosporium*, of which there are seven

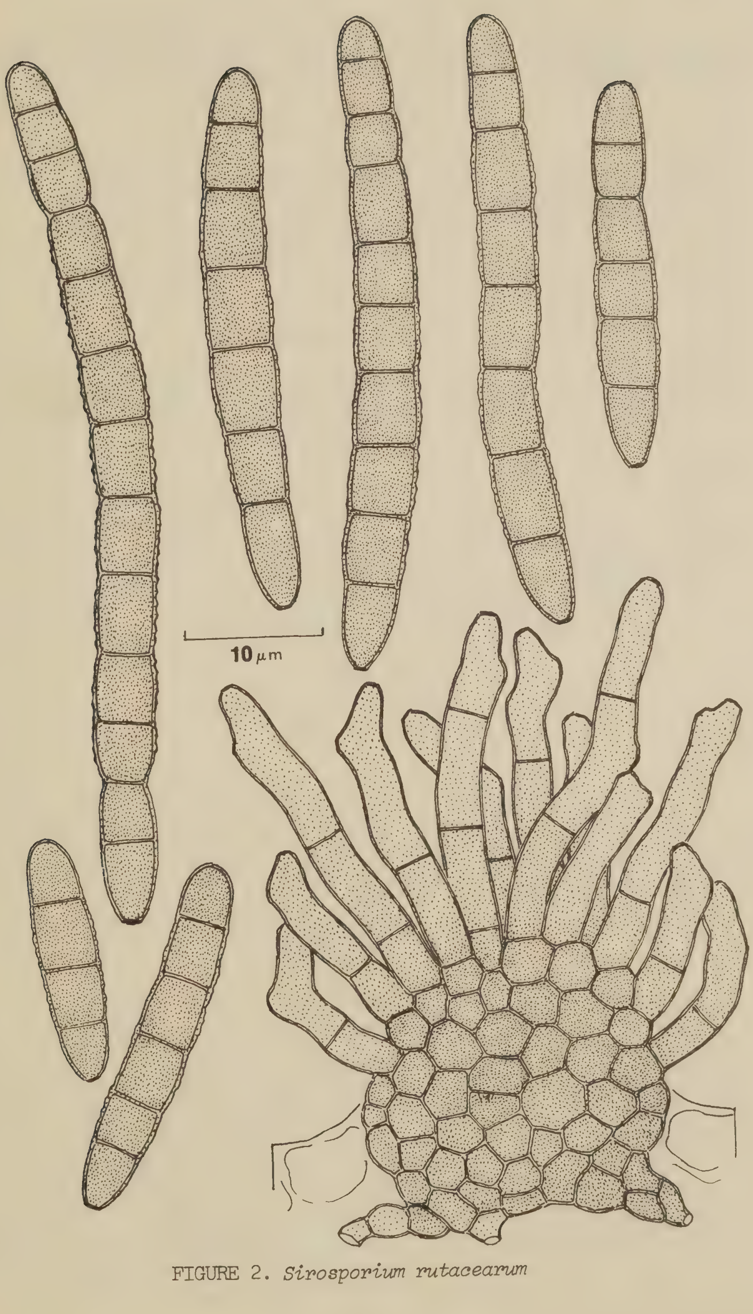

FIGURE 2. *Sirosporium rutacearum*

species described to date, *S. rutacearum* is broadly similar to *S. gliricidiae* (Sydow) Deighton. It differs significantly from it, however, in the morphology of its conidia.

ACKNOWLEDGMENT

We thank Dr. J. Leland Crane, State Natural History Survey Division, Champaign, Illinois, for kindly reviewing the manuscript.

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MYCOTAXON

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DENTICULARIA LIMONIFORMIS, LEMKEA SPHAEROSPORA AND MYCOENTEROLOBIUM PLATYSPORUM (HYPHOMYCETES): NEW RECORDS FOR NORTH AMERICA

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In this paper three species hitherto unknown from continental North America are reported: *Denticularia limoniformis* de Hoog, *Lemkea sphaerospora* Morgan-Jones and Sinclair, and *Mycoenterolobium platysporum* Goos.

Denticularia limoniformis de Hoog, Persoonia 10:51. 1978.

De Hoog (1978) described *D. limoniformis* based on a specimen associated with a basidioma of *Hyphodontia breviseta* (Karst.) J. Eriksson (Corticiaceae, Basidiomycotina) sent to him by J. Eriksson from Sweden. Eriksson and Ryvarden (1976) had earlier illustrated both *H. breviseta* and *D. limoniformis*, referring to the latter as an unknown hyphomycete.

In 1983 a widely effused specimen of *H. breviseta* was collected in Onondaga County, New York on a well-decayed, fallen conifer trunk. Microscopic examination revealed the presence of *D. limoniformis* (Figs. 1 & 2) associated with the hymenial papillae characteristic of *H. breviseta*. Although the hyphae and conidiophores of *D. limoniformis* were interspersed with the hyphae of *H. breviseta*, no physical connections were observed between the nodose-septate, hyaline basidiomycete hyphae and the simple-septate, faintly pigmented *D. limoniformis* hyphae.

Attempts to isolate D. limoniformis in pure culture were unsuccessful; both conidium and mass-hyphal isolations were attempted. Similar efforts made by de Hoog (1978) were likewise unsuccessful.

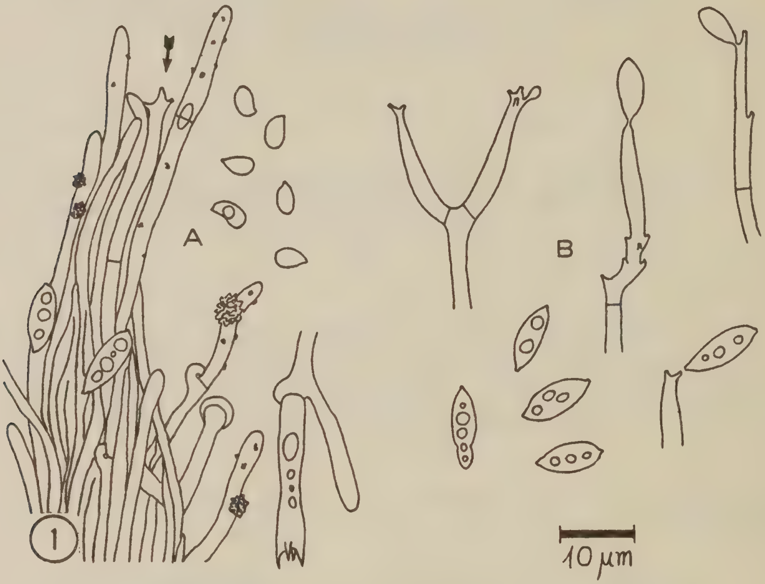


Fig. 1. Hyphodontia breviseta and Denticularia limoniformis (Chamuris 1742). A. Basidiospores and nodose-septate hyphae of H. breviseta mixed with conidiogenous cell (arrow) and conidia of D. limoniformis. B. Conidiogenous cells and conidia of D. limoniformis. x1000.

Two additional American specimens of D. limoniformis were located among 29 packets of H. breviseta held in the Center for Forest Mycology Research (CFMR). One specimen was collected in Montana by R. Gilbertson, the other in Michigan by H. Burdsall. At our request, J. Ginns examined nearly 60 Canadian collections at the National Mycological Herbarium, Ottawa, but D. limoniformis was not seen. Of the eight American specimens of H. breviseta in our mycological herbarium

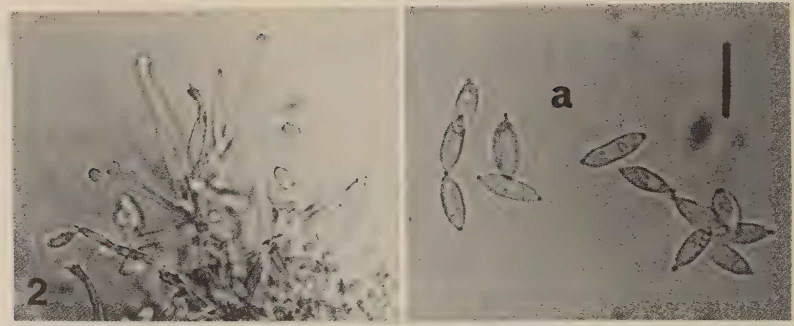
(SYRF), none bore *D. limoniformis;* however one specimen from Sweden deposited by J. Eriksson had the associated fungus.

SPECIMENS EXAMINED (all associated with *H. breviseta):* USA. MICHIGAN: Emmet Co., N. of Wycamp Lake, on well-rotted *Thuja occidentalis*, H.H. Burdsall 3569, 14 Sept. 1969 (CFMR); MONTANA: Glacier National Park, Anaconda Creek, on *Pinus ponderosa*. R.L. Gilbertson 6097, 15 July 1966 (CFMR ex ARIZ); NEW YORK: Onondaga Co., Highland Forest, on fallen, well-decayed conifer (*Pinus* sp.?), coll. K. & S.P. Falk, G.P. Chamuris 1742, 9 Oct. 1983 (SYRF, NY, NYS). SWEDEN. Halland, Fjärås par., Tjolöholm, on fallen trunk of *Pinus sylvestris*, J. Eriksson, 24 Sept. 1965 (SYRF).

Lemkea sphaerospora Morgan-Jones and Sinclair, Mycologia 75:159. 1983.

Morgan-Jones and Sinclair (1983) erected the genus *Lemkea* to accommodate the single species *L. sphaerospora* which was collected in South Africa. They gave the following description: "Conidiophores macronematous,... abundantly branched giving a shrubby appearance, in the fertile part giving rise to a series of ascending conidiogenous loci by sympodial proliferation and somewhat geniculate... Conidiogenous cells monoblastic, discrete, determinate, spherical or subspherical...becoming cupulate after conidium secession by invagination of the wall in the upper part..." Four specimens collected in New York fit the description (Figs. 3 & 4). The globose brown conidia of specimen 11668 (Fig. 3) measure 9-11 µm in diam as do those in the type. However, conidia of the other three specimens are slightly larger, up to 14 µm in diam (Fig. 4).

SPECIMENS EXAMINED: SOUTH AFRICA. TRANSVAAL: Mariepskop, holotype on decaying wood, R. C. Sinclair, 1 Dec. 1981(AUA). USA. NEW YORK: Chautauqua County, Brockton, on decaying *Populus grandidentata* Michx., Wang 11668, 22 Sept. 1979; Onondaga County, Fayetteville, Green Lakes State Park, on decaying wood, Wang 11640, 6 Oct. 1978, Wang 10821, 30 Sept. 1982; St. Lawrence County, Star Lake, on decaying wood, Wang 11449, 8 Sept. 1974 (SYRF).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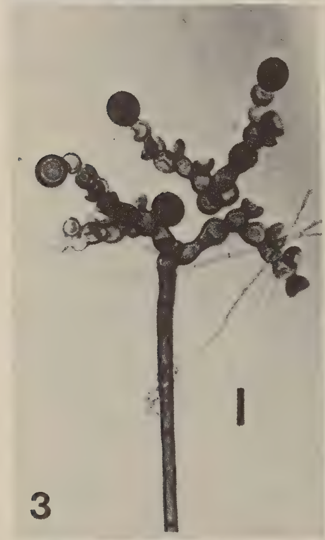
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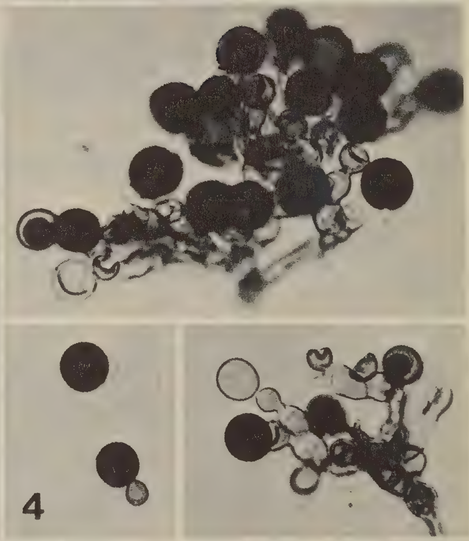
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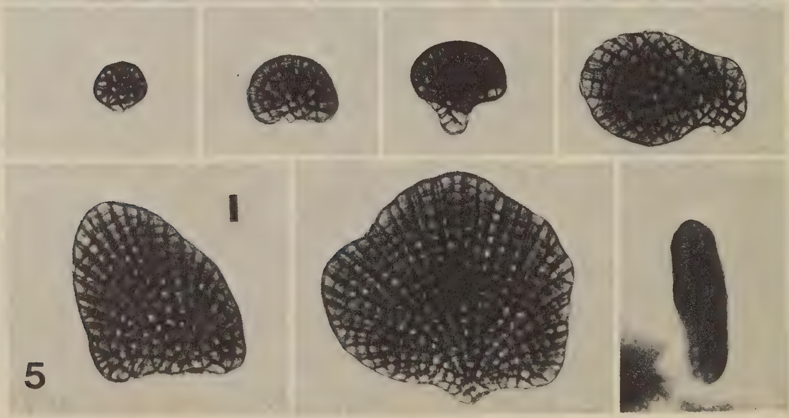
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◁ Fig. 2. Denticularia limoniformis (Chamuris 1742). Conidiogenous cells and conidia, x500. a, x1000. Bar=10μm. Figs. 3 & 4. Lemkea sphaerospora. Conidiophore, conidiogenous cells and conidia. 3. Wang 11668. 4. Wang 11449. All x500. Bar=10μm. Fig 5. Mycoenterolobium platysporum (Wang 10823). Front and side views of conidia. All x400. Bar=10μm.

Mycoenterolobium platysporum Goos, Mycologia 62:172. 1970.

Mycoenterolobium is a monotypic genus of wood-inhabiting hyphomycetes described by Goos (1970). Mycoenterolobium platysporum produces unusual dictyosporous conidia which are strongly flattened (Fig. 5). The rather large (110-130 x 70-80 μm) reniform, semicircular to flabelliform conidia are visible on the substratum with a dissecting microscope, owing to their large, dark and shiny character.

When first described, M. platysporum was known only from its type locality, Oahu, Hawaii. Since then, this species has been found in India (Goos, pers. comm.), Cuba (Holubová-Jechová and Mercado Sierra, 1984), and New York State (present report).

SPECIMEN EXAMINED: NEW YORK: Onondaga County, Fayetteville, Green Lakes State Park, on decaying wood, Wang 10823, 30 Sept. 1982 (SYRF).

It is our belief that these and other species with disjunct, worldwide "distributions" are probably widely distributed. Reports of infrequently encountered fungi probably reflect more the location of mycologists (or where they collect) than the actual distribution of the fungi. It is expected, therefore, that the species reported herein will be found in other parts of the world.

ACKNOWLEDGMENTS

Loans of specimens of *Hyphodontia breviseta* from the Center for Forest Mycology Research, Madison, Wisconsin (CFMR), and of the type of *Lemkea sphaerospora* from Dr. G. Morgan-Jones (AUA) are greatly appreciated. We thank Dr. J. Ginns for examining collections of *H. breviseta* in the National Mycological Herbarium, Ottawa (DAOM). Our appreciation is extended to Dr. G. Morgan-Jones for reviewing the manuscript.

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NOTES ON WOOD-ROTTING FUNGI ON JUNIPERS IN THE GULF COAST REGION

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SUMMARY

Twenty-five species of wood-rotting basidiomycetes are reported on **Juniperus virginiana**, **J. silicicola**, and **J. ashei** in the Gulf Coast region in an area from Texas to Mississippi. Most of these fungi decay bark or wood on live or dead branches of living trees. All cause decays of the white rot type. **Dendrothele itihummensis** is described as new and **Marasmiellus juniperinus** and **Vararia gomezii** are reported from the United States for the first time.

Juniperus virginiana L., eastern red cedar, has a wide natural range in North America, ranging from eastern Canada into Florida and from the Atlantic Coast to western Nebraska and North Dakota (Little, 1971, maps 31W and 31E). It does not occur naturally in the lower Mississippi River Valley or Mississippi Delta region of Louisiana but is commonly used as an ornamental, particularly in cemeteries, throughout southern Louisiana. **Juniperus silicicola** (Small) Bailey (southern redcedar), also occurs in Louisiana and east Texas in several scattered localities (Little, 1971, map 29E). Wood-rotting fungi were collected on this host in Fontainebleau State Park, St. Tammany Parish, LA. **Juniperus ashei** Buchholtz (Ashe juniper) occurs in northern Arkansas, southern Missouri, Oklahoma, and mainly in central Texas (Little, 1971, maps 21W and 21E). Wood-rotting fungi were collected on this host in the vicinity of Austin, Travis County, TX.

This paper presents information on wood-rotting basidiomycetes collected on these three juniper species in an area including central Texas, Louisiana, and eastern Mississippi. With the exception of **Naematoloma fasciculare** and **Hyphoderma praetermissum**, all of the 25 species included here were collected from living trees. These were fruiting on bark on live trunks or branches, or on dead branches. The only comprehensive publications on wood-rotting fungi on North American junipers are those by Gilbertson and Lindsey (1975, 1978), who reported 32 species on Arizona junipers. It is of interest that none of these found in Arizona was collected on the junipers in the present research. The USDA host index (1965) lists 21 species of wood-rotting basidiomycetes (mostly polypores) on **J. virginiana** and **J. silicicola** over their entire ranges, but only one of these, **Dendrothele nivosa**, was collected by us in this study.

The branch habitat occupied by most of these fungi is one where rapid drying results in low moisture conditions for long periods during the year. The fungi that grow and fruit there must have the ability to develop and sporulate rapidly, or to remain dormant, revive, and sporulate rapidly when limited periods of adequate moisture occur. The species of **Aleurodiscus**, **Dendrothele**, **Heterochaete**, **Vararia**, and **Scytinostroma** have basidiocarps characterized by a catahymenium. The basidia arise at different levels as probasidia. These usually have thickened walls and may remain dormant in this stage for months. When favorable temperature and moisture conditions occur, they resume development and the basidia elongate through the layer of hyphidia until the apices are exposed. Other genera reported here have basidiocarps with a euhymenium and lack any obvious morphological adaptations to the exposed branch habitat. They all have fibrous to waxy basidiocarps with the ability to survive long periods of dessication. None of the species included here has been reported to cause a brown rot and all are known or suspected white rot fungi. This is surprising as 31 per cent of the fungi on Arizona junipers were brown rot fungi.

Microscopic characters were determined from free hand sections or squash mounts in phloxine and 2% KOH and in Melzer's reagent. Drawings were made with a camera lucida on a Leitz Labolux microscope.

KEY TO WOOD-ROTTING FUNGI ON JUNIPERS IN THE GULF COAST REGION

1. Hymenophore tubular 2
1. Hymenophore smooth, hydnaceous or lamellate 5
  2. Basidiocarps consisting of single, free tubes ....**Henningsomyces candidus**
  2. Basidiocarps with hymenophore consisting of united tubes.....3
3. Basidiospores cylindric, with minute echinulae in rows, appearing longitudinally striate ....**Pachykytospora alabamae**
3. Basidiospores subglobose to broadly ellipsoid 4
  4. Basidiospores subglobose; hyphae simple-septate ....**Ceriporia xylostromatoides**
  4. Basidiospores broadly ellipsoid; generative hyphae with clamps ....**Schizopora paradoxa**
5. Hymenophore lamellate 6
5. Hymenophore smooth or hydnaceous 8
  6. Tissue turning green in KOH ....**Anthracophyllum lateritium**
  6. Tissue not turning green in KOH 7
7. Basidiocarps small, sessile on bark of living trunks and branches .... **Marasmiellus juniperinus**
7. Basidiocarps large, stipitate in clusters around base of dead trees and stumps ....**Naematoloma fasciculare**
  8. Basidia vertically septate 9
  8. Basidia nonseptate 10
9. Hymenial surface with minute aculei; basidiospores broadly allantoid, thin-walled; hyphae with clamps ....**Heterochaete shearii**
9. Hymenial surface smooth; basidiospores broadly ellipsoid, thick-walled; hyphae simple-septate ....**Sebacina epigaea**
  10. Hymenophore smooth or nearly so 11
  10. Hymenophore hydnaceous ....**Hyphodontia juniperi**
11. Dextrinoid dendrohyphidia or dichohyphidia present 12
11. Dextrinoid hyphidia not present 13

12. Dextrinoid dendrohyphidia present; basidiospores subglobose ....**Scytinostroma portentosum**

12. Dextrinoid dichohyphidia present; basidiospores fusiform ....**Vararia gomezii**

13. Amyloid lyocystidia present ....**Tubulicrinis medius**

13. Amyloid lyocystidia not present 14

14. Conical, heavily incrusted cystidia present 15

14. Conical, heavily incrusted cystidia not present 17

15. Hymenial surface purplish gray to purplish brown; basidiospores allantoid; clamps present 16

15. Hymenial surface cream colored to pale buff; basidiospores ellipsoid; clamps absent ....**Phanerochaete flavido-alba**

16. Hymenial surface dark to pale purplish brown; margin white ....**Peniophora albobadia**

16. Hymenial surface dark purplish gray; margin concolorous ....**Peniophora junipericola**

17. Gloeocystidia abundant and conspicuous 18

17. Gloeocystidia absent or inconspicuous 19

18. Hymenial lamprocystidia present; basidiospores broadly allantoid; stephanocysts usually present .**Hyphoderma praetermissum**

18. Hymenial lamprocystidia absent; basidiospores broadly ellipsoid; stephanocysts not present ....**Hypochnicium eichlerii**

19. Basidiospores amyloid; dendrohyphidia with amyloid incrustation ....**Aleurodiscus botryosus**

19. Basidiospores not amyloid; dendrohyphidia, if present, without amyloid incrustation 20

20. Catahymenium with finely branched dendrohyphidia present ..21

20. Euhymenium present; dendrohyphidia not present 24

21. Basidiospores large, up to 27 µm long and 21 µm wide; echinulate ....**Dendrothele nivosa**

21. Basidiospores smaller, up to 15 µm long and 8 µm wide; smooth ..22

22. Basidiospores biapiculate ....**Dendrothele itihummensis**

22. Basidiospores ellipsoid to subglobose 23

23. Basidiospores narrowly ellipsoid to cylindric-ellipsoid, 9.5-12 x 5-6 µm ....**Dendrothele pachysterigmata**

23. Basidiospores broadly ellipsoid to subglobose, 8-11 x 6.5-8 µm ....**Dendrothele griseocana**

24. Basidiospores thin-walled, 4.5-5.5 x 3.5-4.5 µm; capitate cystidioles present ....**Hyphoderma sambuci**

24. Basidiospores with thickened walls, 6-7 x 5-5.5 µm; capitate cystidioles absent...................**Hypochnicium lundellii**

ALEURODISCUS BOTRYOSUS Burt, Ann. Missouri Bot. Gard. 5:198. 1918.

Basidiocarps effused in small patches or these confluent up to 2 cm, well developed specimens cracking deeply into small blocks on drying; hymenial surface white to pinkish cream, smooth, appearing slightly farinaceous under a 30 x lens; margin abrupt, fertile; hyphal system monomitic, obscured by abundant crystalline material throughout basidiocarp; subicular hyphae thin-walled, simple-septate, with occasional branching, 2.5-4 µm in diam; dendrohyphidia abundant, much branched, with incrustation strongly amyloid in Melzer's reagent, often originating from a swollen basal cell, branching apex mostly 10-12 µm long; pseudocystidia apparently present but infrequent, difficult to distinquish from immature basidia, cylindric to ventricose or clavate, apex rounded to mammillate, 50-65 x 8-13 µm; basidia utriform to clavate, 2-4 sterigmate, 45-65 x 12-20 µm, simple-septate at the base, sterigmata stout, arcuate, 14-20 x 4-5.5 µm; basidiospores broadly ellipsoid to ovoid, hyaline, smooth to shallowly tuberculate, amyloid in Melzer's reagent, 13-20 x 8-12.5 µm, with a prominent, blunt apiculus. Fruiting on bark on living branches. MB 1663, on **J. virginiana**, LSU campus, Baton Rouge, East Baton Rouge Parish, LA; MB 2086, on **J. virginiana**, State Capitol Grounds, Baton Rouge; MB 1717, on **J. virginiana,** Fontainebleau State Park, St. Tammany Parish, LA.

ANTHRACOPHYLLUM LATERITIUM (Berk. et Curt.) Sing., Lilloa 22:206. 1951.

Basidiocarps sessile, attached by a small, densely hirsute, lateral or dorsal knob; pilei circular to reniform, 5-20 mm wide, pileus surface reddish brown or orange-brown, turning darker and finally black with age, finely tomentose, radially rugose, azonate, incurved at the margin; gills thick, distant, pale rusty brown, becoming blackish with age, hymenium extending over surface between gills so that entire lower surface is fertile; margin rounded, entire, gills ending abruptly at lateral hirsute attachment point; context yellowish brown, soft-fibrous, up to 1 mm thick; tissues giving off a reddish exudate in alcohol and a dark greenish exudate in KOH, tissues appearing bright green in KOH under the compound microscope, the color slowly fading or leaching out with addition of phloxine, tissue showing scattered streaks and patches with strongly amyloid hyphal walls and granular material in Melzer's reagent; hyphal system monomitic; contextual hyphae thin to firm-walled, with abundant clamps, with frequent branching, 2.5-6.5 µm in diam; cystidia or other sterile hymenial elements absent; basidia clavate, 2-sterigmate, 30-45 x 7.5-10 µm, with a basal clamp, the sterigma stout, up to 3 µm wide and 10 µm long; basidiospores ellipsoid, some curved at the base, slightly pigmented, smooth, negative in Melzer's reagent, 11.5-13 x 6-8 µm. MB 1939, 1944, 2011, all on dead branches of living **J. virginiana**, LSU campus, Baton Rouge.

CERIPORIA XYLOSTROMATOIDES (Berk.) Ryv. et Johan., Prelim. Polyp. Fl. East Africa. p. 276. 1980.

Basidiocarps annual, resupinate, effused up to 5 cm, developing in small, confluent patches; pore surface white to cream colored, the pores circular to angular, 4-5 per mm, with thick, entire dissepiments; context white to cream colored, soft-fibrous, less than 1 mm thick; tube layer concolorous with context, up to 1.5 mm thick; hyphal system monomitic; subicular generative hyphae simple-septate, thin-walled, with occasional branching, 2-4 µm in diam; tramal hyphae similar; cystidia or other sterile hymenial elements absent; basidia broadly clavate, 4-sterigmate, 12-14 x 6-7 µm, simple-septate at the base; basidiospores broadly ovoid to subglobose, hyaline, smooth, negative in Melzer's reagent, 4.5-6 x 4-5 µm. MB 2309, LSU campus, Baton Rouge, on bark at base of living **J. virginiana. Ceriporia xylostromatoides** commonly fruits around the base of living, declining, or dead ornamental plants, particularly those irrigated by flooding. This suggests that it may be a root-rot pathogen.

DENDROTHELE GRISEOCANA (Bres.) Bourd. et Galz., Bull. Mycol. Soc. France 28:354. 1913.

Basidiocarps resupinate, effused in small patches up to 1 cm; hymenial surface white to pale ochraceous, smooth; margin abrupt to thinning out, adnate; hyphal system monomitic; hyphae obscured in crystalline material, thin-walled, simple-septate, 2-3 µm in diam; dendrohyphidia inconspicuous, branches very slender and obscured by incrusta-

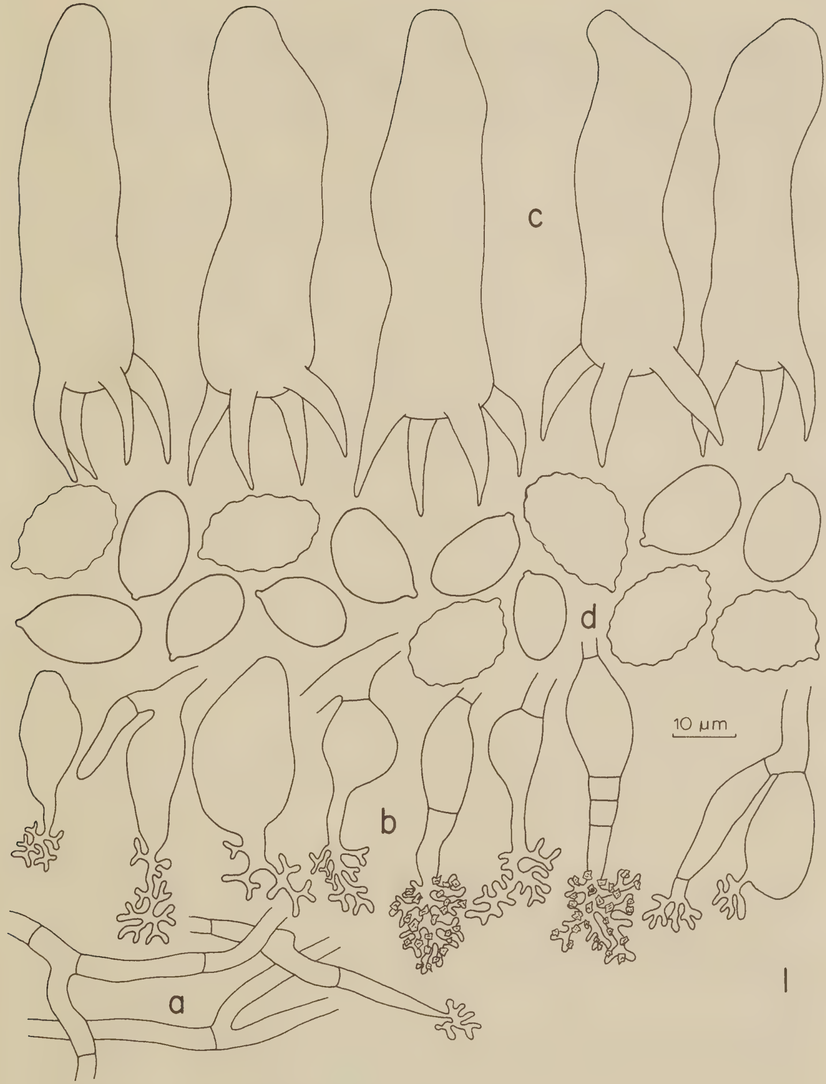
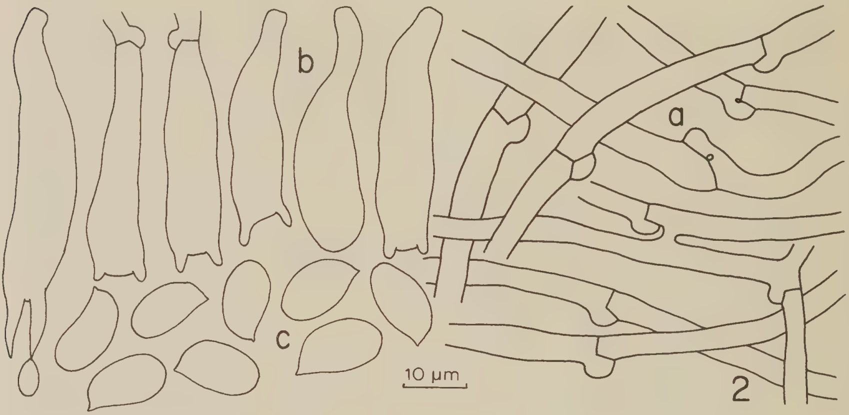


Fig. 1. **Aleurodiscus botryosus** (MB 2086). a, subicular hyphae; b, dendrohyphidia with swollen bases; c, basidia; d, basidiospores.

tion; pseudocystidia broadly fusoid, thin-walled, some appearing empty, others with yellowish, refractive contents, these darkening in sulphobenzaldehyde, 35-42 x 9-11 µm; basidia utriform to clavate, 2-4 sterigmate, 25-35 x 8-10 µm, simple-septate at the base, sterigmata stout, arcuate, 5-7 x 1.5-2.5 µm; basidiospores broadly ellipsoid to ovoid or subglobose, hyaline, smooth, negative in Melzer's reagent, 8-11 x 6.5-8 µm. Fruiting on bark on living and dead branches of **J. virginiana**. MB 1630, Lafayette, Lafayette Parish, LA; MB 2096, State Capitol Grounds, Baton Rouge. Lemke (1964) gives a wide host and geographical range for **D. griseocana**.



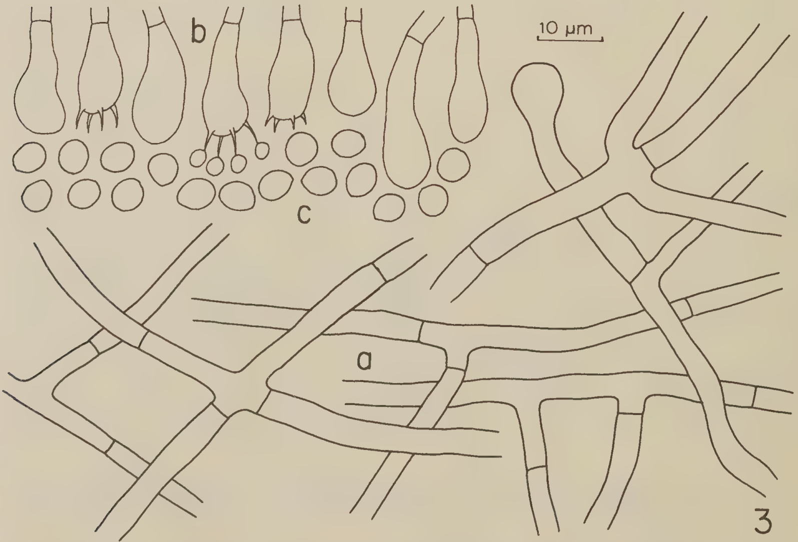
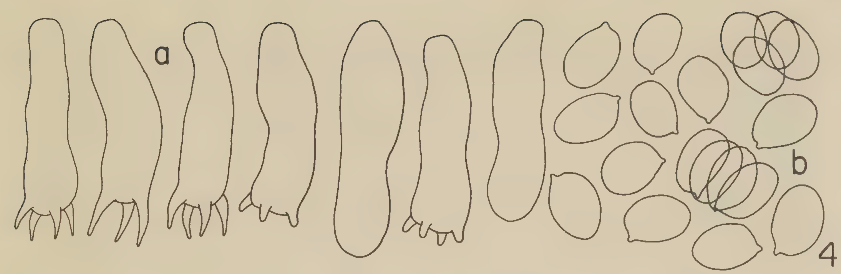


Fig. 2. **Anthracophyllum lateritium** (MB 1944). a, contextual hyphae; b, basidia; c, basidiospores. Fig. 3. **Ceriporia xylostromatoides** (MB 2309). a, subicular hyphae; b, basidia; c, basidiospores.



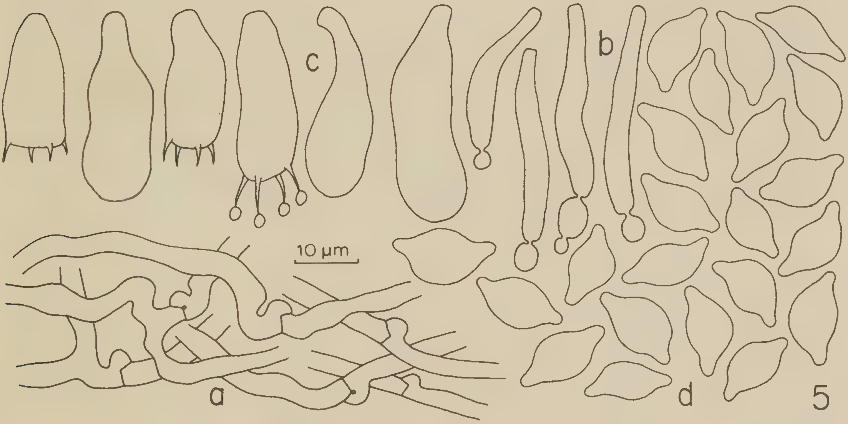


Fig. 4. **Dendrothele griseocana** (MB 2096). a, basidia; b, basidiospores. Fig. 5. **Dendrothele itihummensis** (MB 2020). a, subicular hyphae; b, moniliform cystidia; c, basidia; d, basidiospores.

DENDROTHELE ITIHUMMENSIS Gilbn. et M. Blackwell, sp. nov.

Fructificatio resupinata, alba vel cremea; systema hypharum monomiticum; hyphae tenuitunicatae, fibulatae; cystidia moniliformae; basidia late clavatae, 22-34 x 8-11 µm; basidiosporae biapiculatae, hyalinae, laeves, nonamyloideae, 12-15 x 5-8 µm. HOLOTYPUS: leg. M. Blackwell, No. 2020, ad ramos **Juniperus virginiana**, LSU campus, Baton Rouge, LA, Nov. 21, 1983; in herb. National Fungus Collections, Beltsville, Md (BPI).

Basidiocarps effused in small patches 3-10 mm wide or these becoming confluent and effused up to 5 cm; hymenial surface smooth, white to cream colored, cracking extensively on drying; subiculum white, very thin, soft; small pieces of basidiocarps easily flaked off with a needle; microscopic structures obscured by copious crystalline material; hyphal system monomitic; generative hyphae thin-walled, with clamp connections, staining brightly in phloxine and often contorted or with irregular constrictions and swellings, 2.5-3.5 µm in diam; cystidia moniliform, 20-35 x 4-4.5 µm; basidia broadly clavate, 4-sterigmate, 22-34 x 8-11 µm, some narrowed abruptly at the base, with a basal clamp; basidiospores biapiculate, hyaline, smooth, negative in Melzer's reagent, 12-15 x 5-8 µm. Associated with a white rot of dead branches of **J. virginiana**. MB 2003, 2006, 2020 (holotype), LSU campus, Baton Rouge; MB 883, Cedar Lane, Beechwood, West Feliciana Parish, LA; MB 3088, Vaughn, Yazoo County, MS. The unusual basidiospores make **D. itihummensis** distinctive in the genus. Other species with irregularly shaped basidiospores include **D. macrodens** (Coker) Lemke, and **D. acerina** (Pers.: Fr.) Lemke forme **tricornis** Bourd. et Galz. **D. macrodens** occurs on hardwoods, mainly on **Fraxinus**, and has much larger spores (10-23 x 11-16 µm) with 2-5 angular projections. **D. acerina** f. **tricornis** lacks clamps and has triangular spores. (Lemke, 1964). **Acanthophysium biapiculatum** G. H. Cunn. has similar but broader spores (9-11 µm) and lacks clamps (Cunningham, 1963). The specific epithet is from Itihumma, an Indian name for Baton Rouge.

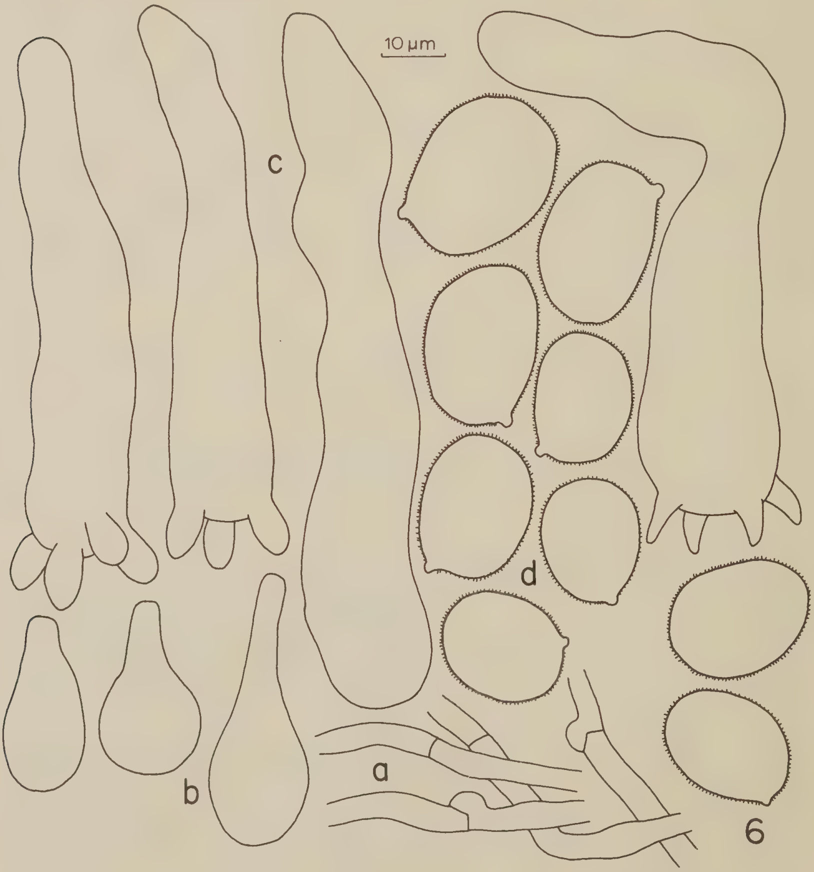


Fig. 6. **Dendrothele nivosa** (MB 619). a, subicular hyphae; b, sterile elements; c, basidia; d, basidiospores.

DENDROTHELE NIVOSA (Berk. et Curt.) Lemke, Persoonia 3:367. 1965.

Basidiocarps effused in small patches 1-15 mm long, circular to elongated or irregular in outline; hymenial surface white, smooth, margin thick, abrupt, adnate; hyphal system monomitic; subicular hyphae obscured in crystalline material, thin-walled with simple septa and occasional clamps, 2-5 µm in diam; catahymenium with slender, branching dendrohyphidia with obscuring crystalline material; sterile elements difficult to distinguish from immature basidia, apparently broadly clavate to cylindric or slightly moniliform, 25-45 x 5-16 µm; mature basidia stoutly clavate, 80-110 µm long, 16-22 µm wide at the apex and 8-10 µm wide at the base, 4-sterigmate, sterigmata stout and blunt, fingerlike before maturity, 5-7 µm in diam and up to 20 µm long; basidiospores broadly ellipsoid to ovoid, hyaline, finely echinulate, negative in Melzer's reagent, 19-27 x 15-21 µm, with a prominent, blunt apiculus. Fruiting on bark on living trunks and branches, presumably utilizing dead, outer bark as a substrate. MB 1656, 2004, 2019, RLG 13354, LSU campus, MB 2095, State Capitol Grounds, Baton Rouge; MB 619, Evangeline State Park, St. Martinville, St. Martin Parish, LA; MB 1626 and 1629, Lafayette, LA; MB 1719 and 1725, Fontainebleau State Park, LA; MB 3091, 3092, 3095, Natchez Trace, Hinds County, MS; MB 3096, Rocky Springs, Claiborne County, MS; MB 1386, Southwestern Univ. campus, Memphis, Shelby County, TN; all the above on **J. virginiana** except 1725 on **J. silicicola**. Widely distributed on junipers in eastern North America and the most common species of **Dendrothele** on junipers in Louisiana.

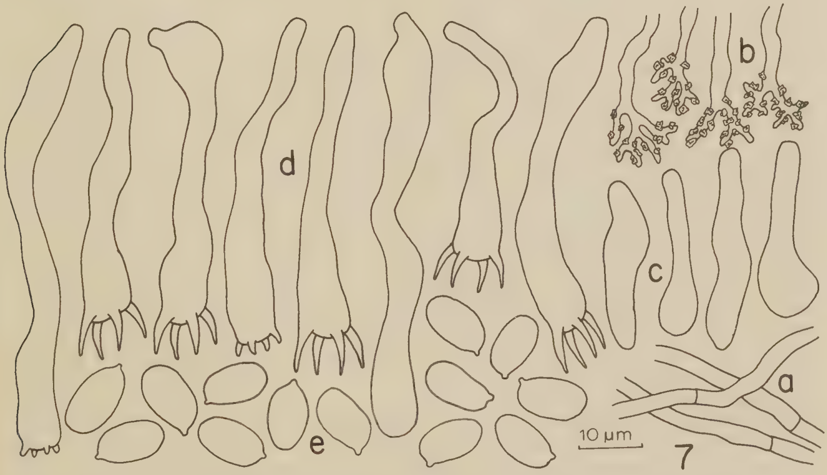


Fig. 7. **Dendrothele pachysterigmata** (MB 2005). a, subicular hyphae; b, dendrohyphidia; c, sterile elements; d, basidia; e, basidiospores.

DENDROTHELE PACHYSTERIGMATA (Jacks. et Lemke) Lemke, Persoonia 3:337. 1965.

Basidiocarps resupinate, effused in small patches up to 3 cm, adnate; hymenial surface white to cinereous with age, smooth to shallowly rugose; margin thinning out; hyphal system monomitic; hyphae difficult to discern because of obscuring crystalline material, thin-walled, with inconspicuous clamps, 2.5-3.5 µm in diam; dendrohyphidia profusely branched, lightly to heavily incrusted; sterile elements fusoid to clavate, 25-30 x 4-6.5 µm, thin-walled; basidia urniform or narrowly clavate, some greatly elongated with a slender median portion, 4-sterigmate, 35-65 µm long, 6-7 µm wide at the apex, sterigmata 5-7 µm long and 1.2 µm wide at the base; basidiospores narrowly ellipsoid to cylindric-ellipsoid, hyaline, smooth, negative in Melzer's reagent, 9.5-12 x 5-6 µm, with a prominent apiculus. Fruiting on bark and decorticated wood of dead branches, associated with a white rot. MB 2005, LSU campus, Baton Rouge, on **J. virginiana**. Not previously known from the southeastern U.S. but reported from Mexico (Lemke, 1964).

HENNINGSOMYCES CANDIDUS (Pers.) O. Kuntze, Rev. Gen. Pl. 3(2):483. 1898.

Basidiocarps developing as individual tubes, gregarious, closely packed but easily separated, white, 600-720 um long and 180-240 um wide, outer surface farinaceous to finely tomentose under a 30x lens; hyphal system dimitic; generative hyphae thin-walled, with obscure clamps, 2-3.5 µm in diam; skeletal hyphae slender, nonseptate, with frequent branching, often dendritic, 1-2 µm in diam, making up outer tomentum; cystidioles fusiform, 18-25 x 4-6 µm; basidia clavate, 2-4 sterigmate, 13.5-20 x 5.5-7 µm; basidiospores subglobose to broadly ellipsoid, hyaline, smooth, negative in Melzer's reagent, 5-7 x 4-5 µm. Associated with a white rot. MB 1718, on dead branches of **J. virginiana**, Fontainebleau State Park, St. Tammany Parish, LA.

HETEROCHAETE SHEARII (Burt) Burt, Ann. Missouri Bot. Gard. 8:377. 1921.

Basidiocarps resupinate, effused up to 6 cm, adnate or with margins separating; hymenial surface pinkish buff to ochraceous brown, with minute, scattered aculei; hyphal system monomitic; subicular hyphae thin-walled, with occasional clamps, 1.5-3 µm in diam, rarely branched; cystidia imbedded or projecting slightly, cylindric to clavate or fusoid, thin-walled, 30-45 x 5-9 µm; dendrohyphidia abundant, thin-walled, main axis 2-4 µm in diam, sparsely branched; hypobasidia subglobose to ovoid or broadly clavate, 14-25 x 9-18 µm, with a single vertical septum at maturity, epibasidia cylindric, up to 40 µm long, 2-4 µm in diam; basidiospores broadly allantoid, hyaline, smooth, negative in Melzer's reagent, 13-17.5 x 6-9 µm, with a stout, blunt apiculus. Associated with a white rot of dead branches of **J. virginiana**. MB 2018, LSU campus, MB 2087 and 2090, State Capitol Grounds, Baton Rouge, LA. This is a rather common fungus in Louisiana, occurring on hardwood substrates also. The regularly 2-celled basidia are distinctive (Bodman, 1952).

HYPHODERMA PRAETERMISSUM (Karst.) John Erikss. et Strid, in Erikss. et Ryv., Cort. North Europe 3:505. 1975.

Basidiocarps resupinate, thin, effused up to 20 cm, adnate; hymenial surface cream colored to pale buff, smooth; margin thinning out; hyphal system monomitic; subicular hyphae thin-walled, with clamps at all septa, hyaline, with occasional branching, 3-4.5 µm in diam; gloeocystidia abundant, imbedded or slightly projecting, cylindric or ventricose, obtuse or fusoid at the apex, highly refractive in Melzer's reagent, 30-100 x 6-12 µm, with a basal clamp; hymenial cystidia cylindric to narrowly clavate, capitate, thin-walled, not incrusted, 40-50 µm long, capitate apex and broad central portion 4.5-6 µm in diam, narrow neck 2.5-3 µm in diam, with a basal clamp; stephanocysts abundant to few in subiculum, spherical with a tapered base, 11-12 µm in diam, with

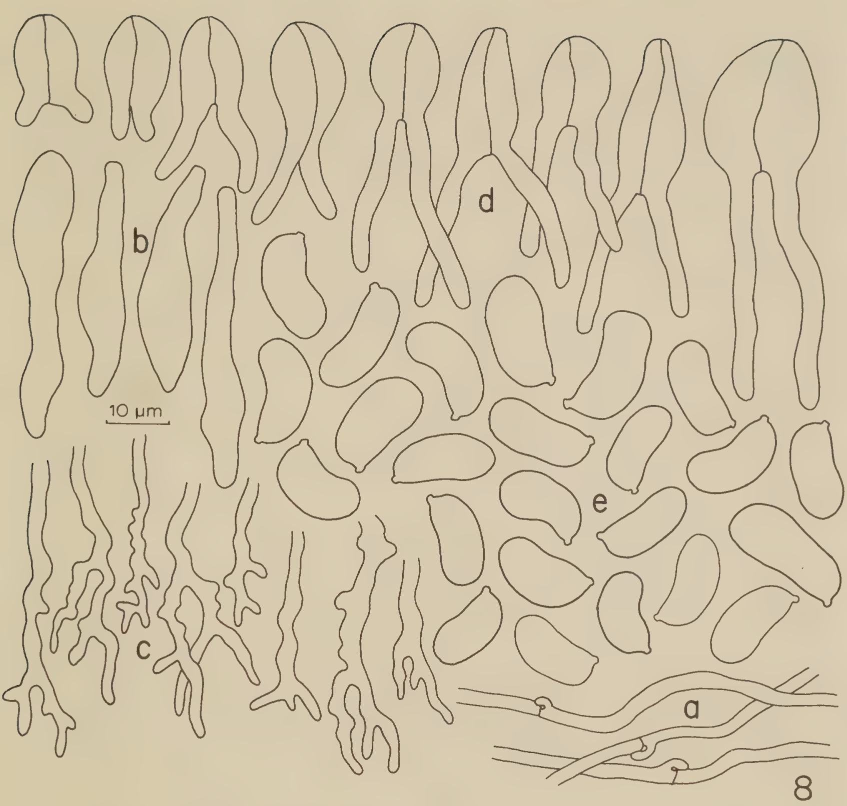


Fig. 8. **Heterochaete shearii** (MB 2018). a, subicular hyphae; b, cystidia; c, dendrohyphidia; d, basidia; e, basidiospores.

a toothed fringe and a basal clamp; basidia clavate, 4-sterigmate, 22-30 x 7-10 µm, with a basal clamp; basidiospores broadly cylindric to somewhat allantoid, hyaline, smooth, negative in Melzer's reagent, 9-12 x 4.5-6 µm. Associated with a white rot of dead, fallen **J. virginiana**. MB 871, Beechwood, West Feliciana Parish, LA. This is a ubiquitous and morphologically variable species on many hardwood and conifer substrates over a wide geographical and ecological range in North America.

HYPHODERMA SAMBUCI (Pers.) Jülich, Persoonia 8:80. 1974.

Basidiocarps annual, resupinate, effused up to 2 cm, soft, membranous; hymenial surface white, smooth, cracking on drying; margin thinning out, loosely floccose; hyphal system monomitic; subicular hyphae thin-walled, closely septate with clamps at all septa, with frequent branching, often branching out of clamps, 2.5-4.5 µm in diam, some lightly incrusted with coarse crystalline material; cystidia capitate, scarcely projecting, 19-30 x 3-4 µm, not incrusted; basidia narrowly clavate with a median constriction, 4-sterigmate, 20-33 x 4-5 µm, with a basal clamp; basidiospores broadly ellipsoid, hyaline, smooth, negative in Melzer's reagent, 4.5-5.5 x 3.5-4.5 µm. Associated with a white rot of dead branches of **J. ashei.** MB 1606, Univ. of Texas Brackenridge Tract, Austin, Travis County, TX. This is a highly variable taxon as defined by Eriksson and Ryvarden (1976). The smooth hymenial surface, broadly ellipsoid spores, capitate cystidia, and hyphal structure of this specimen fall within the concept of **H. sambuci.**

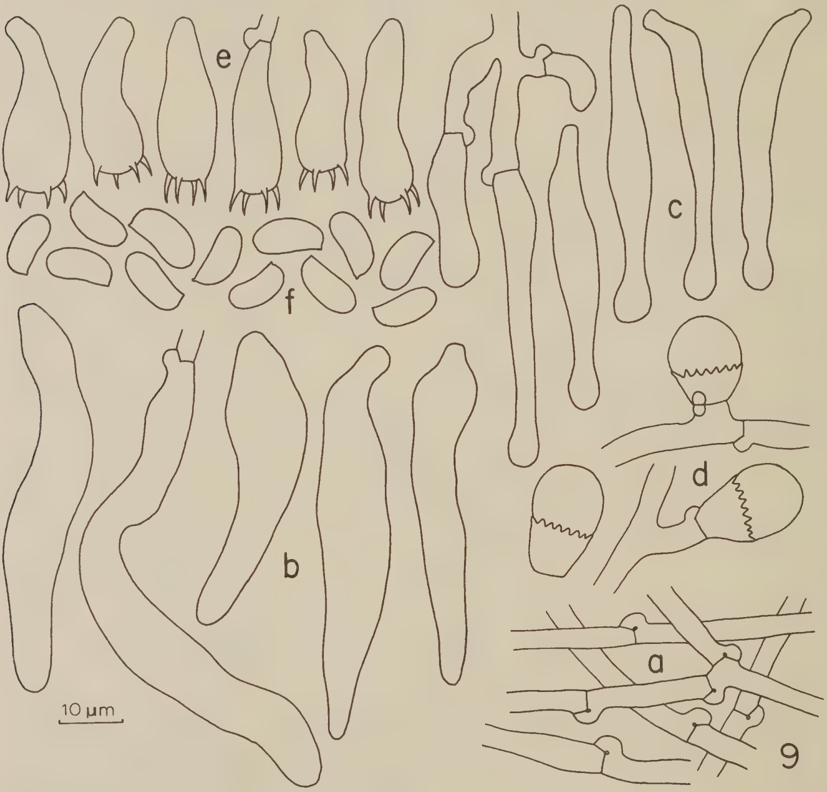
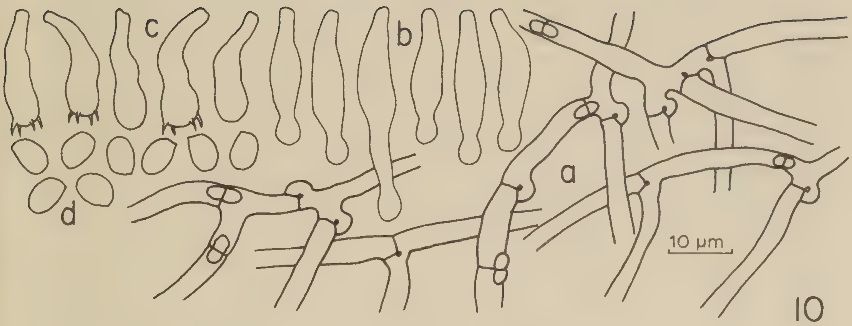


Fig. 9. **Hyphoderma praetermissum** (MB 871). a, subicular hyphae; b, gloeocystidia; c, hymenial cystidia; d, stephanocysts; e, basidia; f, basidiospores.

HYPHODONTIA JUNIPERI (Bourd. et Galz.) John Erikss. et Hjortst., in Erikss. et Ryv., Cort. North Europe 4:666. 1976.

Basidiocarps resupinate, effused up to 5 cm, crustose; hymenial surface white to cream colored, hydnaceous with short, scattered aculei, hymenium continuous over surfaces between aculei, cracking deeply into small, irregular blocks on drying; margin concolorous, thinning out, floccose or radially fimbriate; subiculum white, soft-fibrous, less than 0.3 mm thick; hyphal system monomitic; subicular hyphae thin-



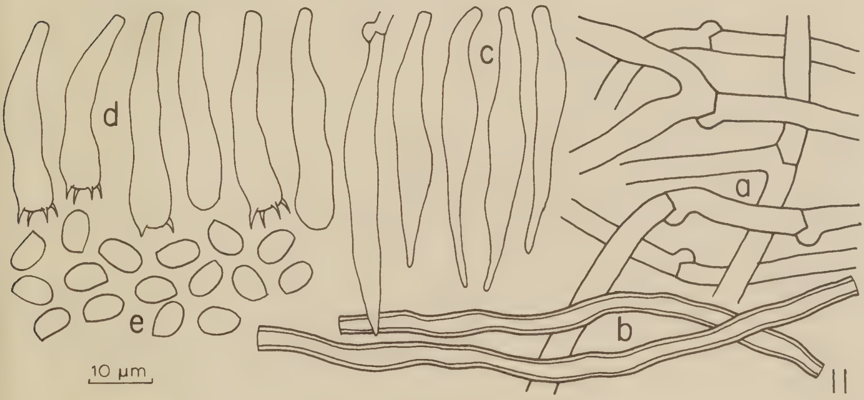
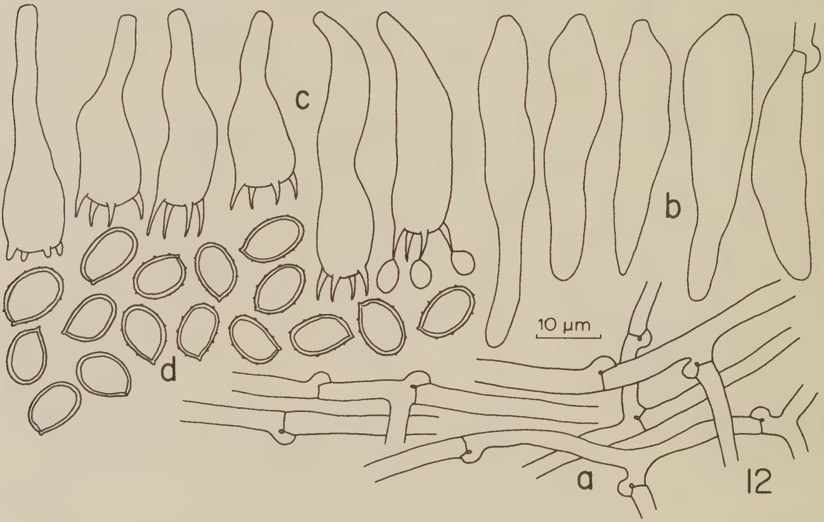


Fig. 10. **Hyphoderma sambuci** (MB 1606). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores. Fig. 11. **Hyphodontia juniperi** (MB 1609). a, thin-walled subicular hyphae; b, firm-walled subicular hyphae; c, cystidia; d, basidia; e, basidiospores.

to firm-walled, with abundant clamps, frequently branching out of clamps or adjacent to septa, 2.5-4 µm in diam, lightly to heavily incrusted with coarse crystalline material present throughout the subiculum; cystidia represented by subulate hyphal ends present at apices of aculei and in hymenium; basidia narrowly clavate with a median constriction, 4-sterigmate, 20-35 x 5-5.5 µm, with a basal clamp; basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 5-6.5 x 3.5-4 µm. Associated with a white rot of dead branches of **J. ashei**. MB 1600 and 1609, Univ. of Texas Brackenridge Tract, Austin, TX. These specimens have the macroscopic aspect of **Hyphodontia crustosa** (Fr.) John Erikss., but the broad, ellipsoid spores are typical of **H. juniperi**.

HYPOCHNICIUM EICHLERI (Bres.) John Erikss. et Ryv., Cort. North Europe 4:407. 1976.

Basidiocarps resupinate, effused up to 10 cm, adnate, cracking into small blocks on drying; hymenial surface cream to ochraceous, smooth; margin thinning out; hyphal system monomitic; subicular hyphae with clamps, thin-walled, with frequent branching, 2-5 µm in diam; gloeocystidia abundant, cylindric to ventricose, apex rounded to fusoid, highly refractive in Melzer's reagent, imbedded or projecting slightly, 35-50 x 7.5-12 µm, with a basal clamp; basidia clavate, often with a narrowed base, 4-sterigmate, 28-41 x 7.5-10 µm; basidiospores ellipsoid, appearing smooth in Melzer's reagent and finely verrucose in KOH and phloxine, hyaline, negative in Melzer's reagent, 8-10.5 x 5-7 µm. Associated with a white rot of dead branches of **J. virginiana.** MB 2092, State Capitol Grounds, Baton Rouge, LA. The ornamentation on the



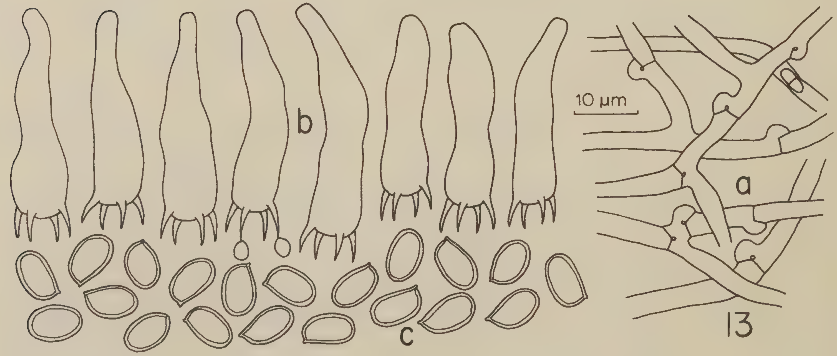


Fig. 12. **Hypochnicium eichleri** (MB 2092). a, subicular hyphae; b, gloeocystidia; c, basidia; d, basidiospores; Fig. 13. **Hypochnicium lundellii** (MB 2023). a, subicular hyphae; b, basidia; c, basidiospores.

spores is dificult to discern with light microscopy but this is reported for the species by Eriksson and Ryvarden (1976) who illustrate "subglabrous spores."

HYPOCHNICIUM LUNDELLII (Bourd.) John Erikss., Symb. Bot. Upsal. 16:1, p. 101. 1958.

Basidiocarps resupinate, effused up to 10 cm, adnate, cracking into small angular blocks on drying; hymenial surface cream colored, smooth; margin abrupt; hyphal system monomitic; subicular hyphae with abundant clamps, thin-walled, with occasional to frequent branching; cystidia or other sterile hymenial elements absent; basidia clavate, 4-sterigmate, 26-40 x 6-8 µm, with a basal clamp; basidiospores ellipsoid, smooth, hyaline, negative in Melzer's reagent, 6-9 (-11) x 4.5-6 µm. Associated with a white rot of dead branches of **J. virginiana**. MB 2023, LSU campus, Baton Rouge, LA. Eriksson and Ryvarden (1976) give the spore size for **H. lundellii** as 6-7 x 5-5.5 µm. Spores of this specimen are slightly larger. However, they are not in the size range of spores of **H. bombycinum** (Sommerf.: Fr.) John Erikss.

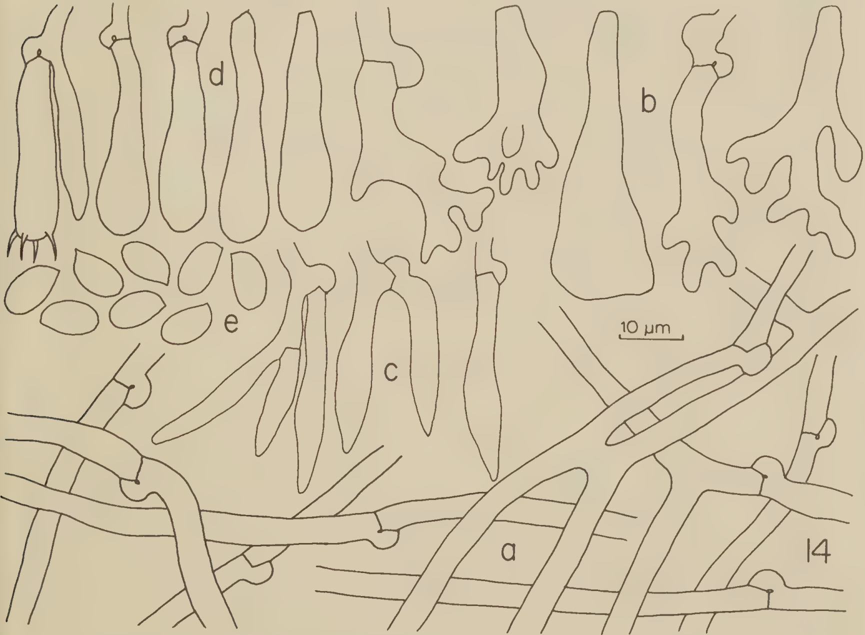


Fig. 14. **Marasmiellus juniperinus** (MB 1424). a, contextual hyphae; b, cheilocystidia; c, fusoid sterile elements; d, basidia; e, basidiospores.

MARASMIELLUS JUNIPERINUS Murr., N. Amer. Fl. 9:243. 1915.

Basidiocarps mostly sessile, attached by a narrowed base or laterally stipitate, some centrally stipitate; pileus dimidiate to circular, up to 12 mm wide, margin becoming inrolled and undulate on drying; upper surface uniformly pale brownish, dry, appearing finely farinaceous or scurfy under a 30x lens; lamellae thick, distant, pinkish buff, adnate to adnexed, edges entire, bluntly rounded, hymenium extending over underside of pileus between lamellae; stipe tan, minutely scurfy, up to .5 mm in diam and 2.5 mm long, bent sharply back and horizontal on most specimens; context continuous with trama, loosely constructed, soft, pale buff, less than 1 mm thick; hyphal system monomitic; generative hyphae thin- to firm-walled, with frequent branching, with clamps at all septa, mostly 3-5 but some up to 8 µm in diam; cheilocystidia abundant, highly variable in shape, some greatly inflated up to 20 µm and with a smooth surface, others with finger-like projections or a papillate surface, still others much branched and lobed like dendrohyphidia; similar hyphal ends also present on pileus and stipe surfaces; fusoid sterile elements intermixed with basidia, not projecting, 17-34 x 3.5-5 µm, with a basal clamp; basidia clavate, 4-sterigmate, 30-35 x 7-8.5 µm, with a basal clamp; basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 8-9 x 4.5-5.5 µm. Fruiting on bark of living branches of **J. virginiana**, associated rot unknown. MB 1424, 1940, 1946, LSU campus, Baton Rouge. **Marasmiellus juniperinus** was described from juniper in Jamaica. Singer (1973) gives the distribution as Jamaica south to Chile and Patagonia. This is apparently the first record of this species from the United States.

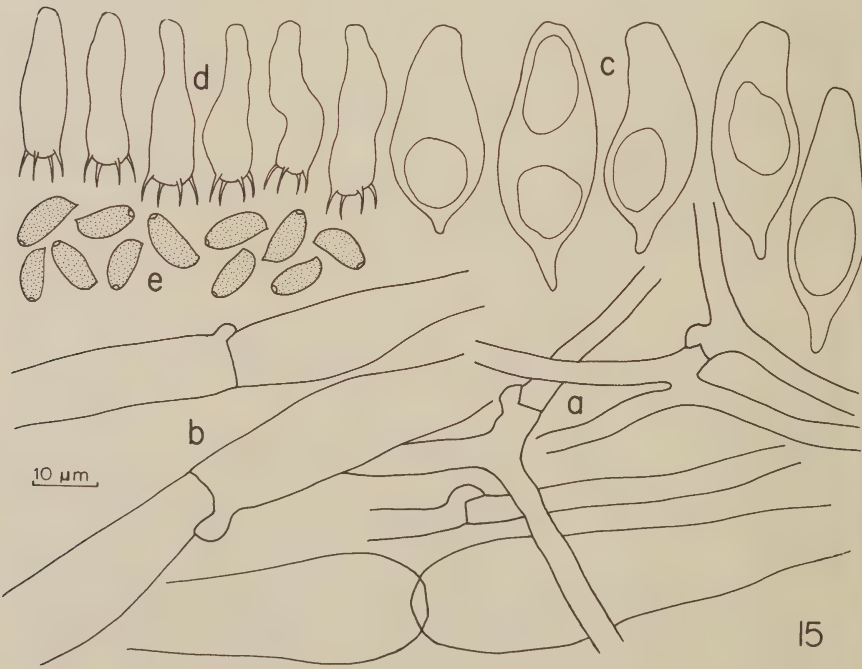


Fig. 15. **Naematoloma fasciculare** (RLG 15012). a, slender contextual hyphae; b, inflated contextual hyphae; c, pleurocystidia; d, basidia; e, basidiospores.

NAEMATOLOMA FASCICULARE (Huds.: Fr.) Karst., Hattsvamp., p. 496. 1879.
Basidiocarps centrally stipitate, clustered; pileus surface gla-

brous, olivaceous or more yellowish green, drying pale to dark dull brown; lamellae yellowish green, adnate, crowded, becoming dark brown on drying; context bright yellow; stipe glabrous to finely tomentose at the base, yellowish to rusty brown, inner tissue bright yellow; hyphal system monomitic; contextual hyphae thin-walled, with clamps and simple septa, some uniformly 2.5-5 µm in diam, with frequent branching, others inflated up to 20 µm in diam, with small clamps and often ampullate; pleurocystidia frequent, broadly clavate with a beaklike projection at the apex, 32-41 x 11-15 µm, often with 1-2 brightly staining, large globules; basidia clavate or with a median constriction, 4-sterigmate, 18-26 x 6-7 µm; basidiospores narrowly ellipsoid to fusoid, pale brownish in KOH, negative in Melzer's reagent, smooth, with an apical germ pore, 6.5-10 x 3.5-4.5 µm; spore print purplish brown. Associated with a white rot. RLG 15012, on stump of **J. virginiana**, Fort Desperate, Port Hudson State Park, West Feliciana Parish, LA.

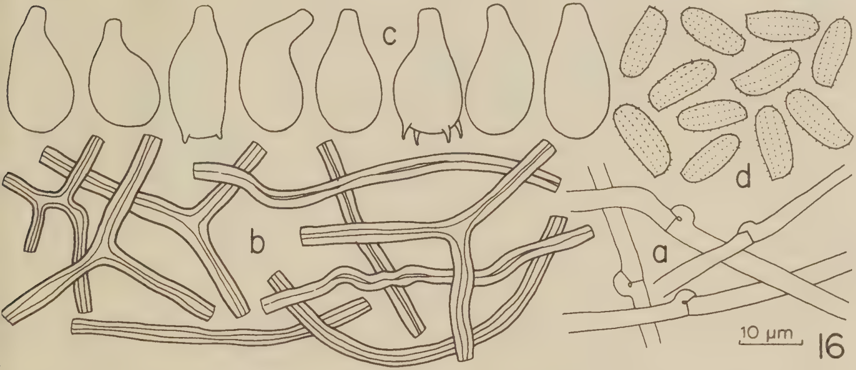


Fig. 16. **Pachykytospora alabamae** (MB 1726). a, generative hyphae; b, skeletal hyphae; c, basidia; d, basidiospores.

PACHYKYTOSPORA ALABAMAE (Berk. et Cke.) Ryv., Norw. J. Bot. 19:233. 1972.

Basidiocarps resupinate, adherent, effused up to 8 cm; pore surface ochraceous buff, the pores circular to angular, 4-6 per mm; dissepiments thin, entire; margin pale buff, soft, tomentose, sterile up to 2 cm, with cupulate developing tubes; tube layer pale buff, up to 1 mm thick; context thin, concolorous with tubes; hyphal system dimitic; subicular generative hyphae inconspicuous, hyaline, thin-walled, negayive in Melzer's reagent, with clamps, 2-2.5 µm in diam; subicular skeletal hyphae thick-walled, nonseptate, slender, with occasional branching, 1.5-3.5 µm in diam, weakly dextrinoid in Melzer's reagent and appearing strongly dextrinoid in mass; cystidia and other sterile hymenial elements absent; basidia broadly clavate, 4-sterigmate, 15-20 x 8-11 µm; basidiospores cylindric, hyaline, minutely echinulate with echinulae tending to be in vertical rows, giving a striate appearance to the spores, negative in Melzer's reagent, 9.5-12.5 x 4-5.5 µm. MB 1724 and 1726, on dead branches of **J. silicicola**, Fontainebleau State Park, St. Tammany Parish, LA. Associated with a uniform white rot.

PENIOPHORA ALBOBADIA (Schw.: Fr.) Boidin, Rev. Mycol. 26:164. 1961.

Basidiocarps resupinate, effused in small patches or these confluent up to 6 cm, adnate or peeling back at the margin; hymenial surface vinaceous to purplish brown or dark brown, fading to pinkish tan, smooth; margin white to cream colored, thinning out, minutely fimbriate; hyphal system dimitic; generative hyphae with clamps, thin- to firm-walled, with occasional branching, 2-4 µm in diam; skeletal hyphae firm- to thick-walled, nonseptate, with rare branching, 1.5-3 µm in diam; dendrohyphidia abundant in hymenial region; cystidia conical, heavily incrusted, 32-38 x 9-11 µm; basidia clavate, 4-sterigmate, 30-35 x 7-8 µm, with a basal clamp, obscured in layer of dendrohyphidia; basidiospores cylindric to allantoid, hyaline, smooth, negative in Melzer's reagent, 10.5-13 x 3.5-5 µm. Fruiting on bark on dead branches of **J. virginiana**, associated with a white rot. MB 2099, State Capitol Grounds, Baton Rouge. **Peniophora albobadia** is a common fungus on dead branches of ornamental shrubs and trees in Louisiana.

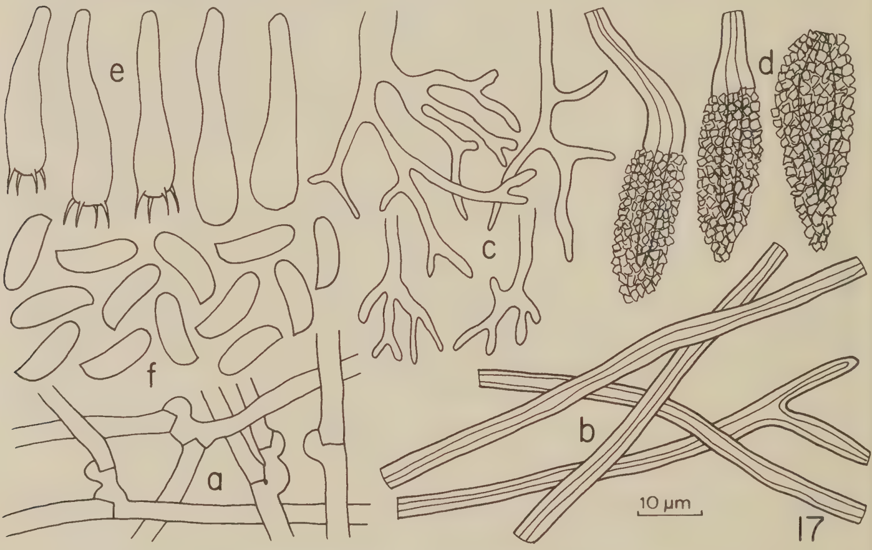


Fig. 17. **Peniophora albobadia** (MB 2099). a, generative hyphae; b, skeletal hyphae; c, dendrohyphidia; d, cystidia; e, basidia; f, basidiospores.

PENIOPHORA JUNIPERICOLA John Erikss., Symb. Bot. Upsal. 10:5, p. 52. 1950.

Basidiocarps annual or perennial, resupinate, thin, effused up to 6 cm., often peeling back from the margin with a thin layer of bark tissue attached; hymenial surface pale purplish gray, smooth, cracking on drying, the margin abrupt, concolorous; context brown, very thin, most of basidiocarp thickness in the pale purplish gray subhymenial layer; hyphal system dimitic; subicular hyphae firm-walled, gelatinized and agglutinated, not easily separable, clamps present but difficult to discern; cystidia abundant in hymenial layer and becoming imbedded in older strata, in some sections seemingly present to the substratum, conical, heavily incrusted with coarse crystalline material, 7-12 µm in diam, incrusted portion 20-30 µm long; gloeocystidia absent; basidia narrowly clavate, 4-sterigmate, 20-25 x 5-5.5 µm, with a basal clamp; basidiospores allantoid, hyaline, negative in Melzer's reagent, 6-8 x 2-3 µm. MB 2000, 2001, 2022, LSU campus, and MB 2085, 2093, State Capitol Grounds, Baton Rouge; MB 3087, Vaughn, Yazoo County, MS, all of the above on dead branches of **J. virginiana**, associated with a white rot. The basidiospores in the specimens cited are smaller than the range given by Eriksson et al. (1978) for European specimens. They agree well in other respects and are better placed in **P. junipericola** than in **P. pithya**, a common species on other conifer substrates, especially spruce logs, in North America.

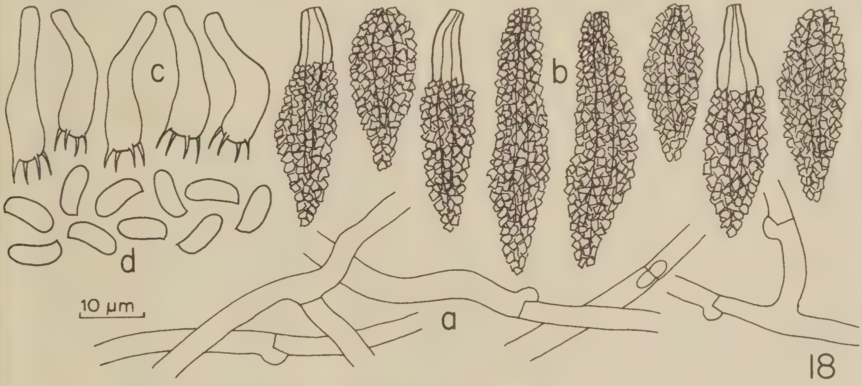


Fig. 18. **Peniophora junipericola** (MB 2000). a, subicular generative hyphae; b, cystidia; c, basidia; d, basidiospores.

PHANEROCHAETE FLAVIDO-ALBA (Cke.) Rattan, Biblio. Mycol. 60:262. 1977.

Basidiocarps resupinate, adnate, effused up to 8 cm; hymenial surface cream colored at first, becoming ochraceous with age, cracking extensively and shrinking into discreet blocks on drying, smooth; margin abrupt or thinning out; hyphal system monomitic; subicular hyphae thin- to firm-walled, simple-septate, 3-6 µm in diam, with occasional branching; cystidia few and scattered to frequent, conspicuous, conical, heavily incrusted except at the base, firm- to thick-walled, 60-90 x 10-18 µm; basidia clavate, 4- or occasionally 2-sterigmate, 22-30 x 6.5-9 µm, simple-septate at the base; basidiospores oblong to narrowly ellipsoid, hyaline, smooth, negative in Melzer's reagent, 6-7.5 (-9) x 3.5-4.5 µm. Associated with a white rot of dead branches of **J. virginiana**. MB 1941 and 2015, LSU campus, Baton Rouge. This is a rather common species on dead branches on hardwoods in the Baton Rouge area.

SCHIZOPORA PARADOXA (Schrad.: Fr.) Donk, Persoonia 5:76. 1967

Basidiocarps annual, resupinate; pore surface cream colored to pinkish buff, the pores circular to angular, 5-7 per mm, dissepiments finely fimbriate under 30x lens; subiculum pale buff, soft-fibrous, up to 1 mm thick; hyphal system dimitic; generative hyphae thin- to firm-walled, with clamps and frequent branching, 2-6 µm in diam, some ending in a globose, thin-walled, swollen apex up to 12 µm in diam; skeletal hyphae prominent, very thick-walled, often almost solid, wall thinning toward the apex in many, nonseptate, unbranched, 3.5-6 µm in diam, some hyphae at dissepiment edges incrusted; cystidioles present in hymenium, fusoid, not or scarcely projecting; basidia clavate with a median constriction, 4-sterigmate, 12-15 x 5-6 µm, with a basal clamp; basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 4.5-5.5 x 3.5-4 µm. Associated with a white rot of dead branches of **J. virginiana**. MB 1631, Lafayette, Lafayette Parish, LA; MB 2007, LSU campus, Baton Rouge.

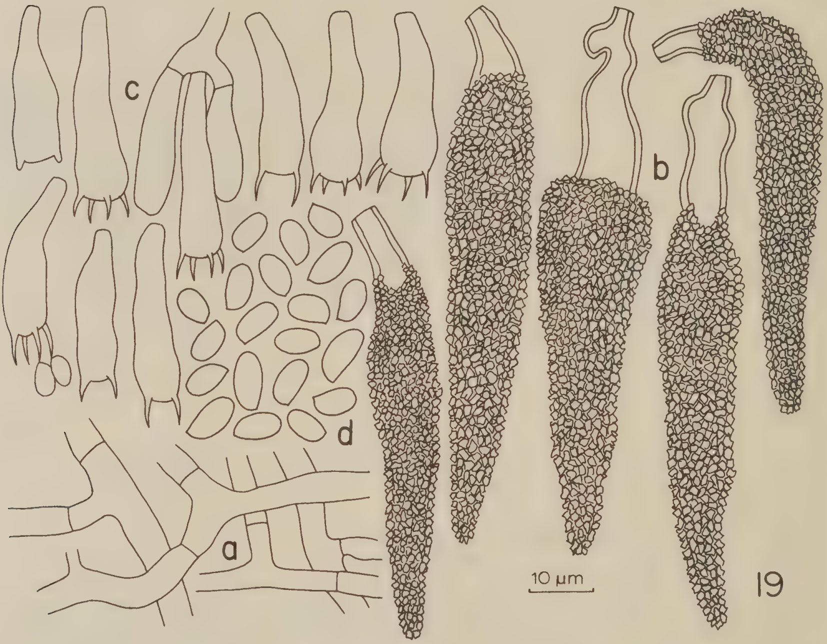
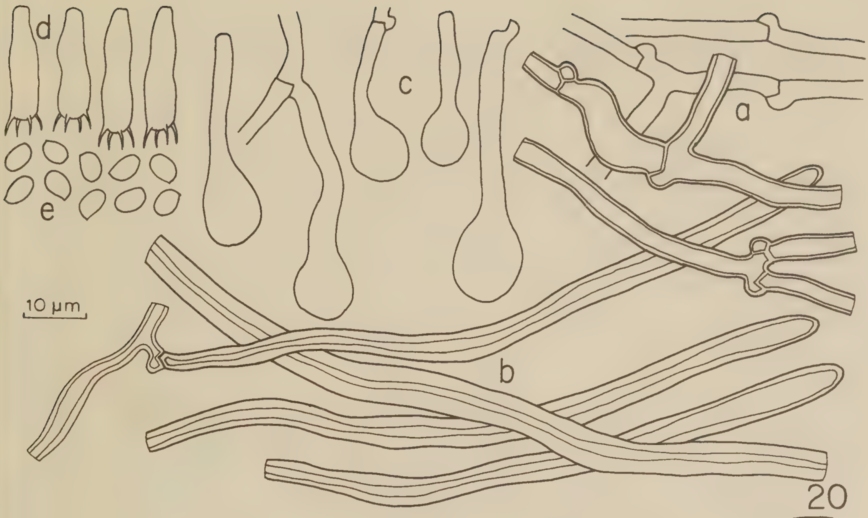


Fig. 19. **Phanerochaete flavido-alba** (MB 2015). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

SCYTINOSTROMA PORTENTOSUM (Berk. et Curt.) Donk, Fungus 26:20. 1956.

Basidiocarps resupinate, adnate, effused up to 15 cm, tough and difficult to tease apart; hymenial surface cream colored to ochraceous with age, smooth; margin abrupt; hyphal system dimitic; sections dextrinoid in Melzer's reagent, tissue composed mostly of dextrinoid skeletal hyphae and densely interwoven, sparsely branched, dextrinoid dendrohyphidia in hymenial region; skeletal hyphae and dendrohyphidia thick-walled; subicular generative hyphae obscure and difficult to discern, simple-septate; cystidia absent; basidia immersed in tangled mass of dendrohyphidia and difficult to discern; basidiospores globose to subglobose, thin-walled, hyaline, smooth, faintly amyloid in Melzer's reagent, 5.5-6.5 µm in diam. Associated with a white rot of dead branches of **J. virginiana**. MB 2089 and 2091, State Capitol Grounds, Baton Rouge.



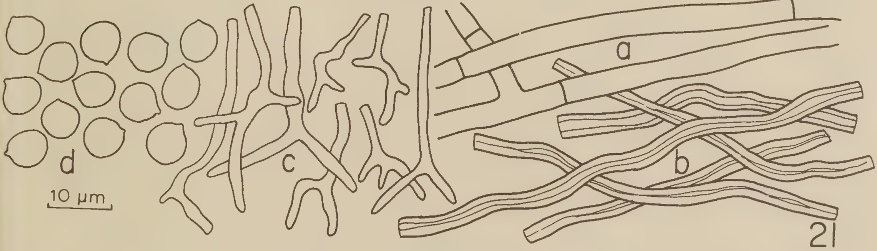


Fig. 20. **Schizopora paradoxa** (MB 2007). a, subicular generative hyphae; b, subicular skeletal hyphae; c, swollen apices on generative hyphae; d, basidia; e, basidiospores. Fig. 21. **Scytinostroma portentosum** (MB 2091). a, generative hyphae; b, skeletal hyphae; c, dendrohyphidia; b, basidiospores.

SEBACINA EPIGAEA (Berk. et Br.) Rea, Trans. Brit. Mycol. Soc. 47:48. 1932.

Basidiocarps annual, resupinate, effused in small patches or these becoming confluent up to 4 cm, waxy to membranous; hymenial surface smooth, cream colored to cinnamon-buff in older areas; margin abrupt to thinning out; hyphal system monomitic; subicular hyphae simple-septate, thin- to firm-walled with occasional branching, 2.5-5 µm in diam; cystidia absent; dendrohyphidia with simple septa present in better developed specimens, branches 2-3.5 µm in diam; basidia globose to subglobose, becoming vertically septate, hypobasidia up to 16 µm in diam, simple-septate at the base; basidiospores ellipsoid, hyaline, thick-walled, smooth, with one to several guttules, negative in Melzer's reagent, 10-13 x 8.5-10 µm. Associated rot unknown. MB 1632, 1771, and 2084, on base of living **J. virginiana**, Clement St., Lafayette, LA. All three specimens cited came from the same tree at the ground line. Only one, MB 2084, has basidia, and these are not well developed. Burt (1915) described **Sebacina deglubens** on juniper in Alabama. This species is now considered a synonym of **Sebacina deglubens** (Fr.) Tul.

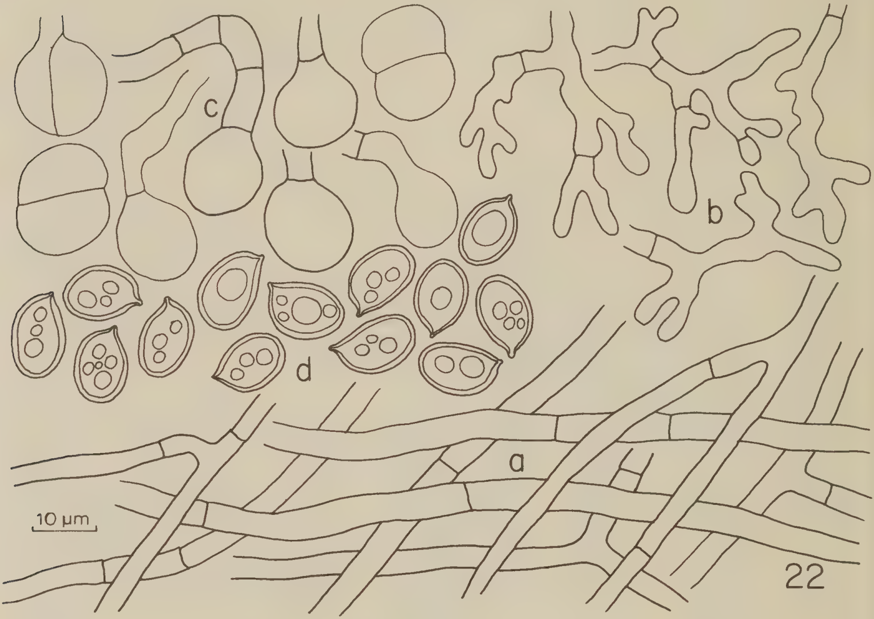


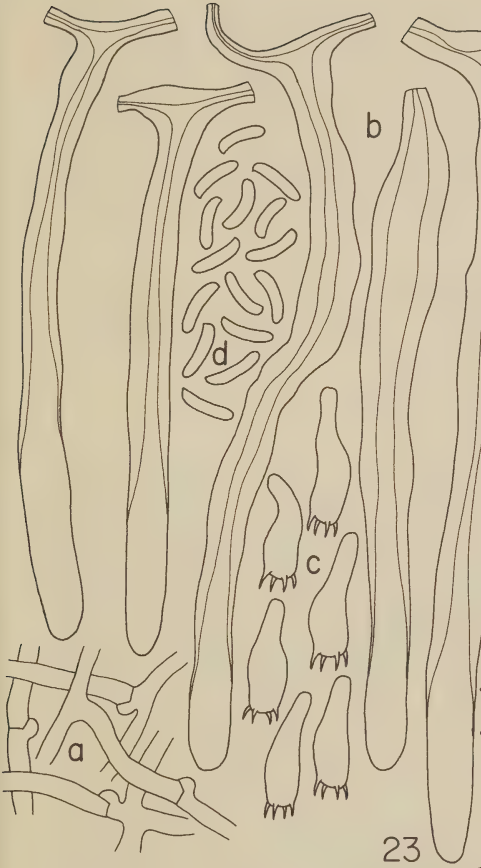
Fig. 22. **Sebacina epigaea** (MB 2084). a, subicular hyphae; b, dendrohyphidia; c, basidia; d, basidiospores.

TUBULICRINIS MEDIUS (Bourd. et Galz.) Oberw., Zeitschr. fur Pilzk. 31:26. 1965.

Basidiocarp annual, resupinate, effused up to 10 cm, thin; hymenial surface pale buff, cracking on drying; hyphal system monomitic; hyphae thin- to firm-walled, with frequent clamps and occasional branching, 2-4 µm in diam; cystidia abundant, tubular, 90-130 µm long and 5.5-10 µm in diam at the widest point, thick-walled, often developing from a branched base and appearing rooted, wall thinning gradually, resulting in a thin-walled apical portion 20-30 µm long and usually not wider than the lower portion of the cystidium, weakly amyloid in Melzer's reagent; basidia clavate, 4-sterigmate, 17-20 x 4.5-6 µm; basidiospores allantoid, hyaline, negative in Melzer's reagent, 7-10 x 1.5-2 µm. White rot of dead, decorticated branches of **J. virginiana.** MB 1657, 1660, 2012, 2016, LSU campus, Baton Rouge.

VARARIA GOMEZII Boid. et Lanq., Bull. Soc. Mycol. France 91:462. 1975.

Basidiocarps effused in small patches or confluent up to 12 cm, soft and easily flaked off with a needle; hymenial surface pinkish buff to cream colored, smooth, cracking on drying; subiculum thin, white; margin abrupt and fertile or minutely fimbriate and sterile; hyphal



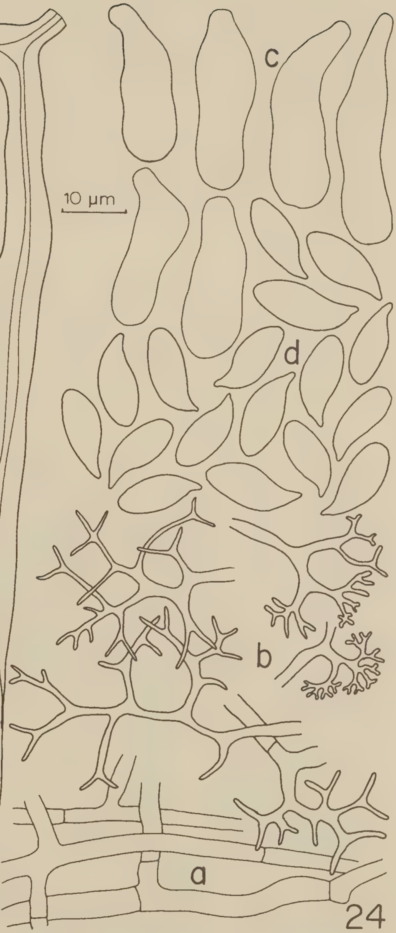


Fig. 23. **Tubulicrinis medius** (MB 2016). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores. Fig. 24. **Vararia gomezii** (MB 2100). a, generative hyphae; b, dichohyphidia; c, basidia; d, basidiospores.

system monomitic; generative hyphae thin-walled, simple-septate, with occasional branching, 1.5-4 µm in diam; dichohyphidia abundant, coralloid, dextrinoid in Melzer's reagent, ultimate branches often tapering to a pointed or attenuated apex; gloeocystidia difficult to differentiate from immature basidia, ovoid to clavate, 6-10 µm in diam, negative in sulphobenzaldehyde reagent; basidia clavate to utriform, 25-37 x 7-9.5 µm, simple-septate at the base; basidiospores navicular, hyaline, smooth, negative in Melzer's reagent, 12-16.5 x 4.5-6.5 µm. Associated with a white rot of dead branches on living **J. virginiana**. MB 1661, 1662, 1664, 1942, 2008, 2009, LSU campus, and 2100, 2102, State Capitol Grounds, Baton Rouge. This taxon has not been previously reported from the United States. Boidin and Lanquetin (1975) originally described it from bamboo in Argentina and later (1977) reported it from Guadeloupe and described the cultural morphology. Boidin et al. (1980) report **V. gomezii** from Gabon and the Central African Republic. The most similar North American species are **V. athabascensis** Gilbn. (Gilbertson, 1969) and **V. thujae** Boid. (Boidin, 1981). Both, however, differ in having clamp connections and mammillate gloeocystidia.

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We express our appreciation to R.E. Halling and J. Boidin, who examined specimens at our request, and to K.K. Nakasone, for a critical review of the manuscript.

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ANAMORPHS OF THE OSTROPALEAN GENERA SCHIZOXYLON AND ACAROSPORINA

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ABSTRACT

Anamorphs were produced from single ascospore cultures of two Ostropalean species. *Schizoxylon lividum* formed a *Trullula*-like anamorph. *Acarosporina hyalina* sp. nov. formed two coelomycete synanamorphs; one, developing arthroconidia, is a *Phacidiella*-like species, the other, developing holoblastic, sympodial conidia, remains unidentified. The generic limits of *Acarosporina* are widened to include species with hyaline ascocarp walls.

INTRODUCTION

Two species of *Schizoxylon* Persoon, *S. sepenicola* Persoon and *S. pseudocyanosporum* Sherwood, and one of *Acarosporina* Sherwood, *A. microspora* (Davidson & Lorenz) Sherwood, have previously been associated with anamorphs (Sherwood 1977a, 1977b). In all three cases the anamorph-teleomorph link was assumed from the two states being consistently found in close proximity on the host.

This paper reports anamorphs formed in culture from single ascospores of *Acarosporina hyalina* sp. nov. and *Schizoxylon lividum* McAlpine. For methods used see Johnston (1983). The anamorphs are compared with those of *Acarosporina microspora* and *Schizoxylon pseudocyanosporum* respectively.

DESCRIPTIONS OF THE FUNGI

1. Acarosporina hyalina sp. nov. (Figs 1,2,3,4,8)

Ascocarpi immersi, profunde cupulati, 0.3-0.7mm diam. Margine albo, crystallino, in sectione transversali 80µm crasso. Stratum parietis 20µm crassum, hypharis 1.5-2µm diam, hyalinis. Stratum crystallinum 30µm crassum. Periphysoidea non ramosa. Paraphyses filiformes, simplices, 1.5-2µm diam. Asci 163-195 x 5-6µm, apice 3.5µm crassi, in iodo caerulescentes, 8-spori. Sporae cellulis 1.8-2µm longis, ad septa se disjunctibus. Holotypus: PDD 45045 ex Actinidia deliciosa (Chev.) Liang & Ferguson.

Etymology: hyalina = hyaline; refers to ascocarp wall colour.

Ascocarps immersed in host hypodermal tissue, flask-shaped, 0.3-0.7mm diam., initially raising the covering host tissue into a small pustule, which then splits to expose the white, crystalline ascocarp margin. Ascocarp margin extending across top of the hymenium, and opening by a small, irregularly-shaped aperture near centre of the ascocarp.

Margin in transverse section up to 80µm wide, comprising three layers; 1, a wall layer, up to 20µm wide, of hyaline, 1.5-2µm diam. hyphae, extending from a short distance below the subhymenium to half way up the ascocarp margin; 2, a crystalline, 30µm wide, wedge-shaped layer in the top half of the margin, extending partially over the hymenium; 3, a 30µm wide layer of cylindrical, unbranched periphyses lines the wall and crystal layers, periphyses amyloid in upper half of the margin. Subhymenium 10-12µm wide, of thin walled, hyaline cells, 3-5µm diam.

Paraphyses filiform, 1.5-2µm diam., undifferentiated at apices, not extending beyond asci. Asci 8-spored, cylindric, 163-195 x 5-6µm; wall thickened up to 3.5µm at apex, with a small central pore, the upper 10-20µm of the ascus wall faintly and diffusely amyloid. Ascospores initially filiform, extending almost the length of the ascus, disarticulating into nonseptate, 1.8-2 x 1.2µm part-spores.

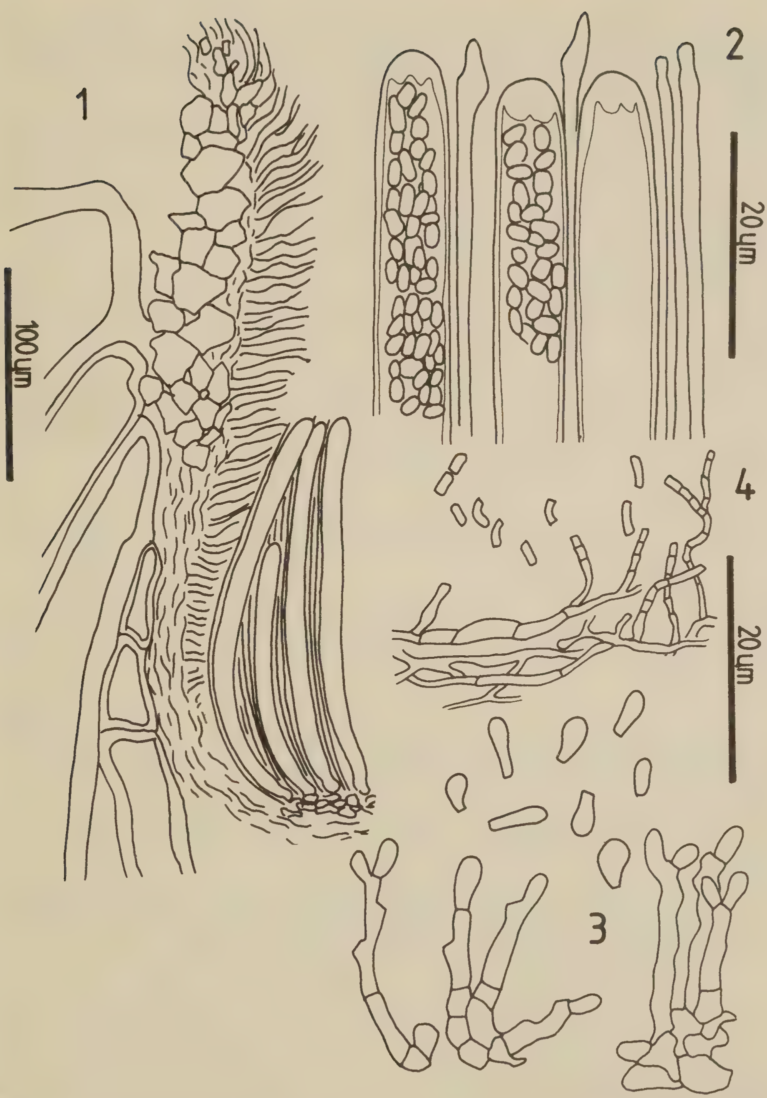


Fig. 1-4 Acarosporina hyalina. Fig. 1 Ascocarp margin in vertical section showing arrangement of wall, crystal, and periphysis layers; Fig. 2 Apices of asci and paraphyses; Fig. 3 Conidiogenous cells and conidia of sympodial synanamorph; Fig. 4 Conidiogenous cells and conidia of arthric synanamorph.

Synanamorphs known only from culture. Ascospores germinating on Difco cornmeal dextrose agar within 24 h. After six weeks growth on oatmeal agar at 20 C colonies 6-7cm diam.; aerial mycelium low, white, cottony to felted; agar pale brown. Pale brown conidiomata scattered on agar surface, 3-4 loculate, walls 10-25μm wide, of hyaline to very pale brown, thin walled hyphae. Pycnidial locules are of two types. The first type of locule with conidiogenous cells cylindrical, unbranched, 8-15 x 1.5-2μm, sympodial, with several broad scars near apices; conidia hyaline, nonseptate, more or less clavate in shape, apex broadly rounded, base truncate, often slightly curved, 3.2-4 x 1.2-1.5μm. The second type of locule with the inner-most layer of wall hyphae extending into the pycnidial cavity, forming occasionally branching, closely septate chains of cells. The chains disarticulate into nonseptate, hyaline, straight or slightly curved arthroconidia, 2.2-3.5 x 0.8(-1.0)μm.

Habitat: Known only from type collection, on a dead twig of Actinidia deliciosa.

Specimen examined: New Zealand, Bay of Plenty, Te Puke, DSIR Research Orchard, on Actinidia deliciosa, G.J.Samuels, S.R.Pennycook, 21.VI.1982 (PDD 45045 - Holotype).

2. Acarosporina microspora (Davidson & Lorenz) Sherwood, Mycotaxon 5:36 (1977) (Figs 5,9)

For a description of the teleomorph see Sherwood (1977a p.36).

In this species evidence for the teleomorph-anamorph link is based on the two states being found in close proximity on the host.

Pycnidia globose, 0.4-0.6mm diam., erumpent, with the base remaining immersed in host tissue, wall dark grey, pruinose. Pycnidia opening widely at maturity. In vertical section pycnidial wall 20-30μm wide with an outer layer of brown to dark brown, thick walled cells present in upper half of pycnidium only, inner layer of the wall comprising hyaline, gelatinised, irregularly branching, 2-2.5μm diam. hyphae. Tips of inner wall hyphae extend into pycnidial cavity, ending as filiform, 0.8μm diam., hyaline, closely septate, occasionally branching elements up to 80µm long. Apical cells of these elements disarticulate and are released as nonseptate, hyaline, straight to slightly curved arthroconidia, 2.5-3.5 x 0.8µm.

Specimen examined: North America, USA, Newfield, N.J. (NY-Ellis 210).

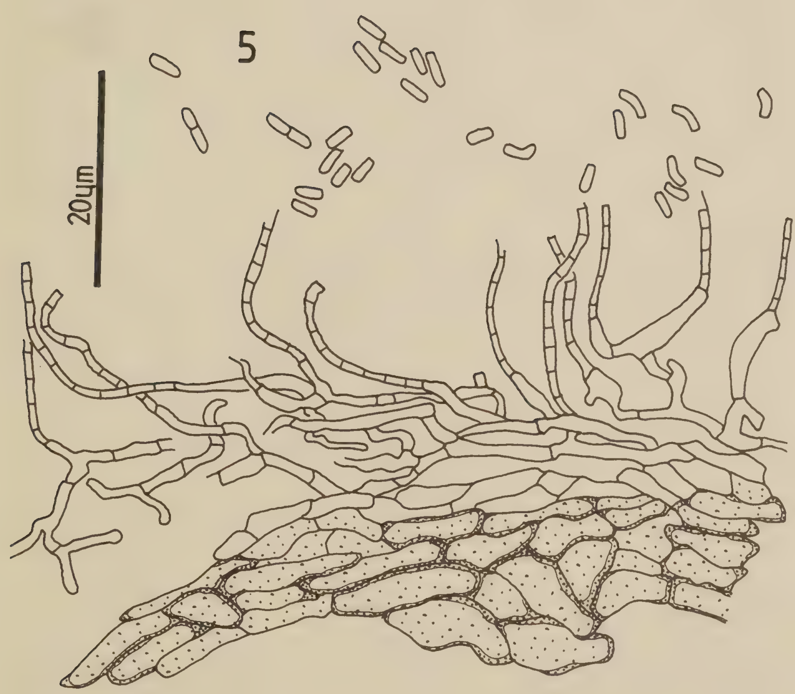


Fig. 5 Anamorph of Acarosporina microspora, pycnidial wall, conidiogenous cells, and conidia.

3. *Schizoxylon lividum* McAlpine, Fungus Disease of Stone Fruit Trees in Australia and their Treatment, (Department of Agriculture, Victoria) p.120 (1902). (Figs 6,10)

=*Schizoxylon gaubae* Petrak, *Sydowia* *8*:208 (1954).

For a description and illustrations of the teleomorph see Sherwood (1977b pp.235-236).

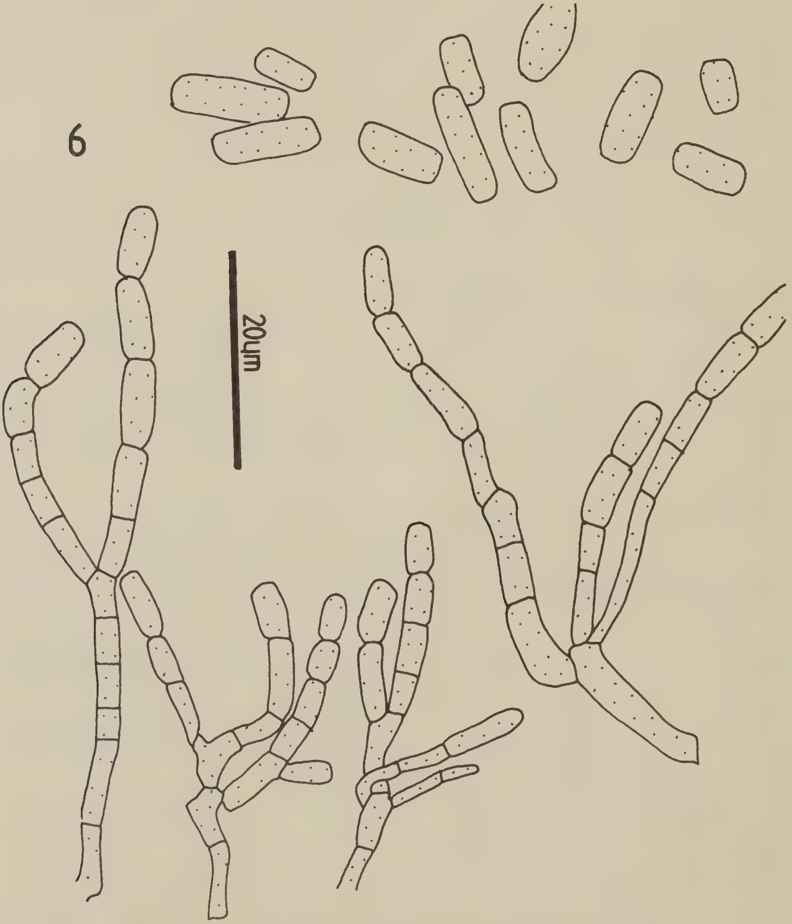


Fig. 6 Anamorph of *Schizoxylon lividum*, conidiogenous cells and conidia.

The anamorph has not previously been reported, and is known only from culture.

Ascospores germinating on Difco cornmeal-dextrose agar within 24 h. After three weeks growth on oatmeal agar at 20 C colonies 2.5-3cm diam.; aerial mycelium white, dense, cottony; agar creamy yellow in reverse. Conidiomata developing on agar surface after 3-4 weeks, globose, 150-350µm diam., walls hyaline, but appearing dark from the black conidial masses held inside. Conidiomata becoming larger, more numerous and often confluent as the colony ages, opening by a pore, or wide, irregular slit. Conidiomatal walls of hyaline, thin walled hyphae; inner layer of hyphae extending into the conidiomatal cavity, forming a palisade of conidiophores. Conidiophores hyaline to pale brown, thin walled, irregularly branching near their bases, with each of the branches forming a chain of conidia, which matures from the apex. Chains disarticulating into nonseptate, thin walled arthroconidia, 5-10.5 x 2-4µm, appearing pale brown under the microscope, and black in mass.

Specimens examined: New Zealand, Wellington, Wellington City, on Cytisus scoparius (L.)Link, G.S.Ridley, VI.1984 (PDD 46209). Australia, New South Wales, E. of Goulburn, on Daviesia latifolia R.Br., E.Gauba, II.1934 (BPI - Holotype of Schizoxylon gaubae).

4. Schizoxylon pseudocyanosporum Sherwood, Mycotaxon 6:241 (1977). (Figs 7,11,12,13)

For a description and illustrations of the teleomorph see Sherwood (1977b pp.241-243).

Sherwood (1977b) notes that a conidial stage, consisting of masses of dark, globose structures embedded in gel, may be associated with the teleomorph. Although there is no cultural evidence, it is likely that these two morphs represent different stages in the life cycle of the same fungus. They occur only in close proximity to each other, in discrete paler areas of the host tissue. No other fungi are found in these areas.

Conidiomata of the anamorph simple in structure, consisting of a shallow depression in the host tissue, round or elliptical in outline, filled with the dark,

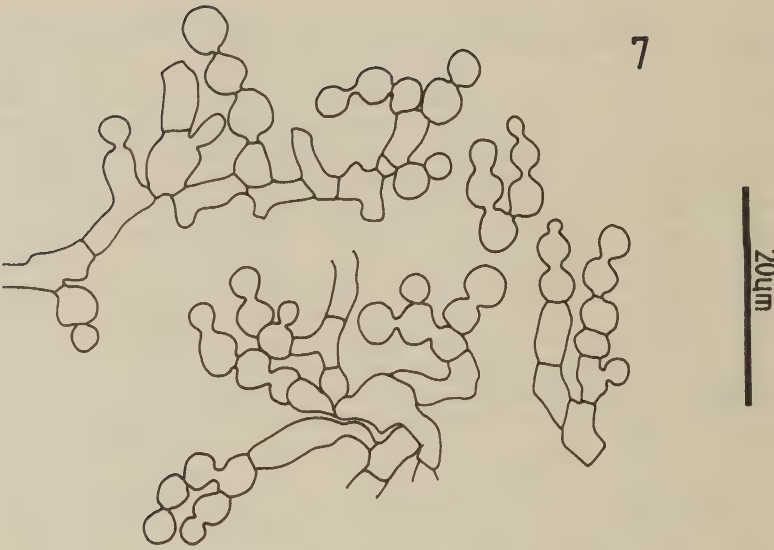
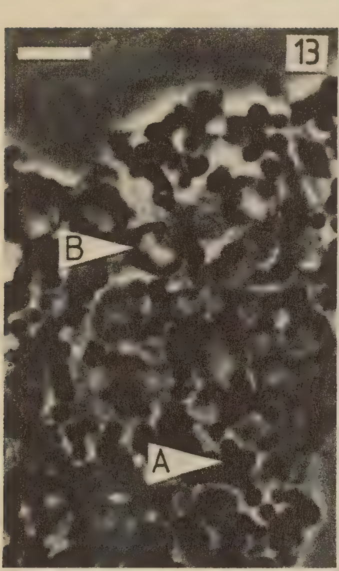


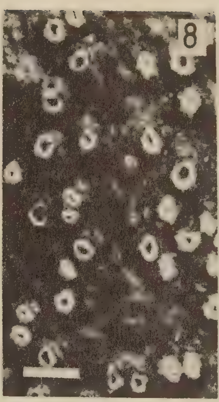
Fig. 7 Anamorph of Schizoxylon pseudocyanosporum, conidiogenous cells and conidia.

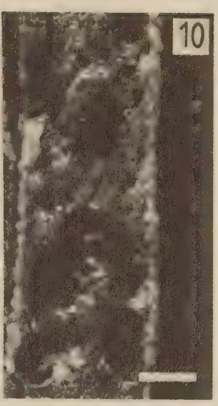
green-black mass of conidia. In vertical section the conidioma is an almost structureless depression in the host tissue, with hyaline, thin walled hyphae amongst surrounding host cells. The conidial mass, arising from the base of the conidioma, is immersed in greenish gel. Within this mass are more or less vertical columns of branching, thin walled hyphae, 2.5-4µm diam., from which short, disarticulating chains of globose, 2.5-3µm diam. arthrospores arise, with spores maturing from the base of the chains. Toward the top of the conidial mass the hyphae become swollen, 6-8µm diam., constricted and sometimes disarticulating at the septa.

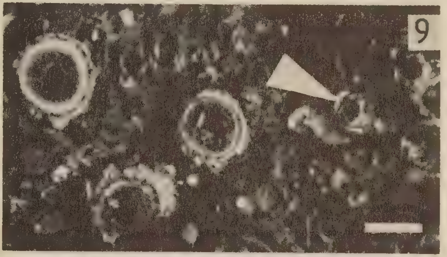
Specimen examined: Pakistan, Kagan Valley, Shogran, on Pinus excelsa Wallich ex D.Don, S.Ahmad, 16.VII.1951 (BPI-Holotype).

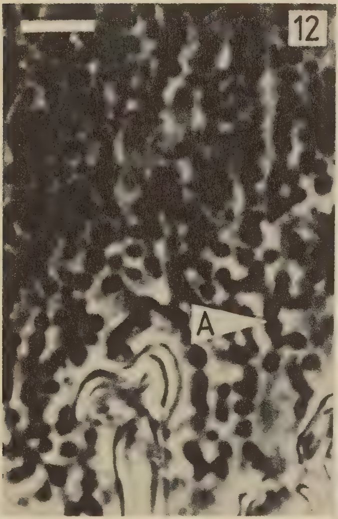
Fig. 8-10 Macroscopic appearnce of ascocarps (scale = 1mm). Fig. 8 Acarosporina hyalina; Fig. 9 Acarosporina microspora (arrow indicates anamorph pycnidium); Fig. 10 Schizoxylon lividum.











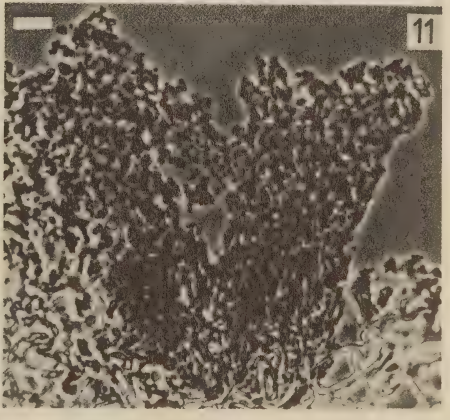


Fig. 11-13 Anamorph of Schizoxylon pseudocyanosporum. Fig. 11 Vertical section of conidioma (scale = 20µm); Fig. 12 Detail of conidial mass near base of conidioma, A indicates a conidial chain (scale = 10µm); Fig. 13 Detail of conidial mass near top of conidioma, A indicates a conidial chain, B indicates a swollen hyphal cell (scale =10µm).

DISCUSSION

Acarosporina

Sherwood (1977a) defined *Acarosporina* as having a thick, dark ascocarp wall, very small part-spores, amyloid asci, and a parasitic habit. *A. hyalina* differs from previously described *Acarosporina* species, including *A. microspora*, in having a hyaline ascocarp wall. Without experimental evidence it is uncertain whether *A. hyalina* is saprophytic or parasitic, but it shares with *Acarosporina* two distinctive characters; very small part spores, and amyloid ascus walls. Amyloid asci are known amongst the Ostropales only in *Acarosporina*, but a number of genera, including *Stictis* Persoon : Fries, have disarticulating ascospores (Sherwood 1977a). *Acarosporina* and *Stictis* are similar in ascocarp margin structure (see illustrations Sherwood 1977a). Sherwood (1977a) considered that taxa with this type of ascocarp structure, and developing as saprophytes, should be referred to *Stictis*.

Sherwood (1977a) described the conidia of the *A. microspora* anamorph as "probably phialidic". My examination showed that conidiogenesis is arthric. From pycnidial morphology and conidiogenesis the anamorph of *A. microspora* can be classified as *Phacidiella* Karsten (see Sutton 1980). The arthric synanamorph of *A. hyalina* differs from *Phacidiella* in lacking a dark pycnidial wall, but shows the same type of conidiogenesis and conidial morphology. The similarity of the *A. hyalina* anamorph (grown from single ascospore isolations) to that of *A. microspora* supports the teleomorph-anamorph link postulated on circumstantial evidence for *A. microspora*.

The synanamorph of *A. hyalina* that has sympodial conidiogenesis cannot be matched with any of the coelomycete genera accepted by Sutton (1980).

Evidence from anamorphs, considered in conjunction with the amyloid asci, suggests that *A. hyalina* is better placed in *Acarosporina* than in *Stictis*. The synanamorphs of *A. hyalina* are different from the anamorphs described for *Stictis* (Johnston 1983). There are some differences between the anamorphs of *A. microspora* and *A. hyalina* however. A. microspora lacks a sympodial synanamorph. The arthric synanamorph of A. hyalina lacks the dark conidiomatal wall of the A. microspora anamorph. Because anamorphs are so far known for only these two Acarosporina species, and as one is known only from the host and one only from culture, it is not yet possible to determine the taxonomic significance of these differences.

Ascocarp wall colour has been used to define genera and sections of genera within the Ostropales. In Stictis the usefulness of ascocarp wall colour as a character, is confirmed by its anamorphs. Those species with dark ascocarp walls (Stictis section Cyclostoma (Crouan & Crouan) Sherwood) have Coleophoma-like anamorphs, those with hyaline walls (Stictis section Stictis Sherwood) have Ebollia anamorphs (Johnston 1983). Whether wall colour proves to be a significant character in Acarosporina awaits the discovery of further anamorphs.

Schizoxylon

The anamorph described by Sherwood (1977a) for Schizoxylon sepenicola is similar to the microconidial states known for many fungi, including other Ostropales (e.g. Stictis carnea Seaver & Waterson and Stictis lata Johnston (Johnston 1983)). Such simple anamorphs at present provide little useful taxonomic information.

The conidiogenous structure of the Schizoxylon lividum anamorph matches Trullula Cesati as illustrated by Pirozynski & Morgan-Jones (1968), but in culture the conidiomata lack the dark brown covering layer typical of Trullula. The anamorph of S. pseudocyanosporum is similar to that of S. lividum only in that both form arthroconidia.

Sherwood (1977b) discussed uncertainties surrounding generic placement of S. pseudocyanosporum in Schizoxylon. The difference in morphology between the anamorphs of S. lividum and S. pseudocyanosporum suggests that as anamorphs are found for more Schizoxylon species, they may be useful in revising the limits of this genus.

The distinction between many Ostropalean genera is often uncertain. Sherwood (1977a p.145) states "A comparison of Stictis dicksoniae with Robergea canariensis, or Stictis quadrinucleata and S. minor with Propolidium pruinosum, will serve to demonstrate that the three genera intergrade." The anamorphs of the Ostropales, although still poorly known, are proving to be diverse in structure. As more Ostropalean anamorphs are found they may provide the extra characters needed to more accurately delimit these genera.

ACKNOWLEDGEMENTS

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A SYNOPTIC KEY TO THE SPECIES OF LAMBERTELLA (SCLEROTINIACEAE), WITH COMMENTS ON A VERSION PREPARED FOR TAXADAT, ANDEREGG'S COMPUTER PROGRAM

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ABSTRACT

Two new species of **Lambertella** are described, **L. rubi** from China and **L. subrenispora** from Japan and India. A synoptic key to 47 currently accepted taxa in the genus is provided. A computer-assisted version using a program devised by Doyle E. Anderegg (TAXADAT) is also available, and comments are provided on the superiority of Anderegg's computer-based key over typical synoptic keys.

INTRODUCTION

In our studies of Discomycete collections from China, Japan, and Southeast Asia, we have dealt with several species of **Lambertella** Höhnel (1918), erected for a single species, **L. corni-maris** Höhn. The genus remained monotypic during the next quarter century. The genus has been monographed twice, both times by workers at Cornell University, first by Whetzel, and later by Dumont. Whetzel (1943) can be credited with establishing a clear generic concept, and with much of the basic biological work on the genus, which he expanded to include eight species, six new, one a transfer. That monograph thus provided a basis for recognition of additional species by various workers. Dumont's (1971) Ph.D. thesis treatment with exceptionally detailed, clear keys to species recognized twenty-nine species based upon examination of a very large number of specimens, bringing the then scattered literature into clear focus. Once again this seemingly definitive monograph stimulated interest in the genus, and served as a basis for recognition of additional, as yet undescribed species, and for establishing synonymy with older, unrecognized species placed under other generic names. Some twenty additional species have been recorded since Dumont's publication (Abdullah and Webster, 1981; Arendholz and Sharma, 1984; Dennis, Reid and Spooner, 1977; Dumont, 1974a, 1974b, 1975, 1976, 1981; Elliott & Sharma, 1976; Gautam, Das, Pant & Tewari, 1982; Korf, 1982; Svrček, 1976; Tewari and Singh, 1972, 1974; Thind and Singh, 1970, 1972). This paper is an effort to bring together in one place, and to provide a key to, the additional material that has been published on the genus since Dumont's monograph appeared, and to two new species described below. It does not pretend to be monographic in scope. The user will still rely in large part on Dumont's (1971) paper, and will need access to the more recent literature to obtain full descriptions of species published elsewhere.

The genus **Lambertella** can generally be characterized by the following features: attacking mature or senescent plant or fungous tissues or on dung; apothecia arising from stromatized host tissues, stromata sometimes being delimited by blackened lines on the surface of the substrate; ectal excipulum composed of textura prismatica, more rarely of textura angularis, sometimes with a defined outer covering layer, often provided with hairs or hair-like outgrowths; medullary excipulum of textura intricata; asci inoperculate, 8-spored or 4-spored, with the pore turning blue or not in Melzer's Reagent; ascospores normally unicellular, uniseriate or biseriate, eguttulate or frequently biguttulate to multiguttulate, with spore walls becoming brown either within the ascus or after discharge, thin and smooth or punctate, often with one side thicker and darker ("banded" in Dumont's terminology), with the guttules frequently masked at maturity; and paraphyses equalling or exceeding the asci in length. The ascospores when discharged in the hyaline state will usually turn brown in one to several days when discharged onto water agar, and germination of ascospores is delayed until the ascospores become pigmented. Many species will produce apothecia and all produce stromata with a thin, characteristic rind (Korf, Aoshima & Campbell, 1966) on nutrient agar in axenic culture.

We have accepted forty-five taxa previously described in the literature, which includes one species in what may not be its original sense (**Lambertella bonahawensis** Dumont sensu Gautam & Pant), and two taxa very poorly known (**L. bouchetii** Grelet and **Phaeociboria brasiliensis** H. Sydow). We describe here one additional species from China, and one from both Japan and India. Forty-nine characters, in which two to eight character states are defined, are provided in the synoptic key. The characteristics used in the key are primarily based upon the original descriptions, and those by Dumont (1971) when amplified there, and were selected as the most useful ones among those which he employed or described. We have reinvestigated a few species where material was available to us in order to obtain information not in the original descriptions.

A computer key, TAXADAT, developed by our colleague, Professor Doyle E. Anderegg, a lichenologist at the University of Idaho, caught our interest when announced in the Mycological Society of America Newsletter, which led to a spirited exchange of correspondence and to refinements in the TAXADAT program. The program, designed to run on Apple II+, IIe, or II-C equipment with at least one disk drive, is available for a modest royalty fee ($25.00) from Prof. Doyle E. Anderegg, College of Letters & Science, Moscow, ID 83843 USA. We have entered our synoptic key in his program, and have found it potentially superior to the synoptic key in printed form such as we present here. Obviously not everyone who wishes to use a key to **Lambertella** species would have available such a computer, or such a program, so the utility of and necessity to provide a printed version remains.

The greatest advantage of the computer version of a synoptic key, such as the one we have developed for **Lambertella**, is the possibility for the user to select a level of "misses" or errors which will still retain a taxon in the system. In the synoptic key (for a full discussion of its use, see Korf, 1972) the user enters the key at any appropriate point by selecting a character state for a character observed in the specimen at hand, and writes down the series of numbers (some authors use mnemonic letters) that identify the different taxa bearing such a character state. The user proceeds to any other character, selecting the appropriate character state, and striking off the numbers that do not apply, until such time as a single number (taxon) remains.

Should the specimen display an abberrant character, or should the key not allow for true variability in a character by failing to have it appear under the selected character state, the real taxon can thus easily be crossed off the list, resulting in a misidentification (or in all numbers being crossed off). The same problem, of course, applies in a dichotomous key when the user chooses the wrong lead. With Anderegg's program, the user selects the number of such "misses" that appears useful, up to a maximum of three or more. The user is regularly informed of the number of taxa still under consideration after making each choice. At any point during the computer-assisted keying session, the user can ask to see the names of those remaining taxa. These will be displayed, along with an indication of the "percentage" correctness to that point in the keying (i.e., the percentage will 100% for those with no misses and be lower for a taxon with more misses than another to which it is compared). This feature alone makes us enthusiastic about the possibility of using computer keys to replace synoptic keys on paper. Eventually the program informs the user that a single taxon remains, and an identification has presumably been achieved. Comparison of one's material with the full description of that taxon may lead one to confirm the identification, or to conclude that perhaps one has a "new" taxon (or at least one not yet entered into the data set).

The user can display or print out a numerical list of the taxa in the data set, and a list of the characters used in the key. It is frequently desirable to print out each of these beforehand for easy consultation during the keying process.

In Anderegg's sophisticated program all character states for each character are displayed, and the user chooses the most appropriate. If the character state is not known or not evident in the material at hand, the user so indicates and the program allows for a successive choice. His program not only allows entry at any point in the key, similar to the synoptic key, but has two other exceptionally useful aspects:

First: during a user-directed search, where the user chooses the order in which characters are searched, at any point (usually after several choices, and when only a few taxa remain under consideration) the user can ask the program itself to select the most appropriate ("best") character for discriminating among the remaining taxa. This can result in a great saving of time, and our request for perfection of this feature was one of the more difficult problems Prof. Anderegg faced in revising his program.

Second: one does not need to search blindly. You can, if preferred, enter the key by using a feature termed "auto-search" in which characters are presented in an order the constructor of the key has chosen, much as in a typical dichotomous (or multilead) key. After each choice (or indication by the user that a choice cannot be made) the program moves on to the next author-selected character.

Despite our obvious enthusiasm for the TAXADAT program and the possibilities it offers for a new way to key fungi effectively, we would be lax in not pointing out a major inherent difficulty. Few laboratories will have the computer located close to the laboratory bench, so that consulting a slide or checking an observation called for in the key becomes awkward. One must thus have a nearly complete description of the specimen for effective use of the computer key.

A computer version of this **Lambertella** key is currently available on a floppy disk, along with Prof. Anderegg's well-documented program to run it, on a licensing basis from him, suitable for use on Apple II+, IIe, and II-C computers with a disk drive, for the same nominal royalty fee he established for his program alone. He has permitted us to send our key and his program (including the documentation and instructions on preparing your own keys) to interested users who submit a blank disk and the royalty fee of $25.00 directly to us. A version of TAXADAT for use on IBM computers is also being prepared by Dr. Anderegg, though we do not have our key to **Lambertella** available on such disks at this time. Those interested in computer-assisted keys working with IBM or IBM-compatible computers should contact him directly.

Both the synoptic key and the computer-based key can be updated by adding additional taxa at the end and entering that taxon number under each character. With somewhat greater difficulty one can increase the number of characters or character states. Since this key to **Lambertella** species relies so heavily on the literature and not on direct examination of specimens, there is a wide disparity amongst taxa in our knowledge of many characters. Not all recent authors have used the full range of characters described by Dumont (1971), particularly the anatomical features of the excipular layers. Thus for many taxa the taxon number will appear under **all** character states (in parentheses in the printed synoptic key). Once these characters are known for any taxon, the parentheses can be removed and the taxon recorded under that state or those states which the taxon actually possesses. Our lack of accurate knowledge of many taxa can be deduced by noting how many times character states appear in parentheses for a given taxon in the synoptic key below.

We intend to update the computer version at irregular intervals, and to advise those who have a previous version of such changes. We encourage authors with information about new taxa, or corrections or additions to the data for previously described taxa, to contact us so that we can add that to our revisions.

TWO NEW SPECIES OF LAMBERTELLA

LAMBERTELLA RUBI Korf & Zhuang, **sp. nov.** FIG. 1

Ab L. zeylanica pilis et asperatis et apice tumidis atque sporis omnino uniseriatis vel uniseriatis biseriatisque, et ab L. acuminata paraphysibus modo unici generis et sporis longioribus quae etiamnum hyalinae emittuntur, differens.

Apothecium discoid to flat, less than 1 mm in diam, stipitate, stipe ca 1.2 mm long, when rehydrated hymenium surface light brown to light vinaceous brown, receptacle surface darker, when dry hymenium light vinaceous brown, receptacle surface hairy, stipe surface downy. **Excipulum** not turning blue in Melzer's Reagent; **ectal excipulum** of textura prismatica, ca 30-40 µm thick, with more or less cylindrical hyphal protrusions (hairs), cell walls in inner and outer layers pigmented and roughened, outer covering layer absent, or if present indistinguishable from the bases of the hairs; **medullary excipulum** of textura intricata, hyphae loosely interwoven, 2.0-7.0 µm broad, hyphal walls hyaline, smooth to roughened. **Hairs** nearly parallel to the outer surface, walls pigmented and roughened. **Hymenium** ca 80 µm thick; **subhymenium** ca 15 µm thick, subhyaline. **Asci** inoperculate, arising from croziers that are difficult to discern, apex thickened, pore wall J+, very faintly blue with two basal dots dark blue with or without KOH-pretreatment, 8-spored, 66-70 X 5.1-6.6 µm, sporiferous part 40-50 µm long. **Ascospores** uniseriate throughout or uni- to biseriate, 6.9-8.8 X 2.6-3.0 µm; when young subfusoid and 2-3-guttulate; at maturity subellipsoid,

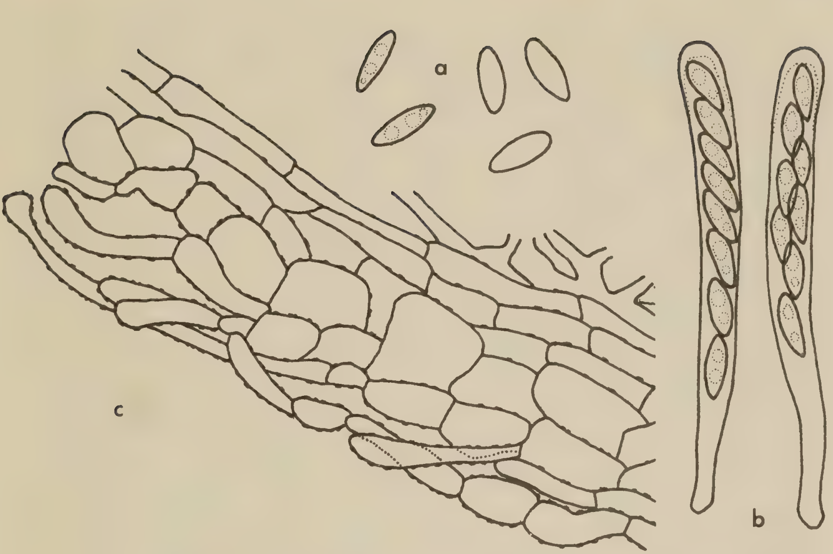


FIG. 1. **Lambertella rubi**, drawn from the holotype (CUP-CH 2346) with the aid of a drawing tube, X1000. a. ascospores; b. asci; c. ectal excipulum.

sometimes very slightly broader at one end, hyaline within asci; after discharge eguttulate, light brown, smooth-walled, sometimes banded. **Paraphyses** cylindrical to slightly swollen at apex, ca 1.6-2.3 µm wide at apex, not or scarcely exceeding asci.

On leaf blades of **Rubus pinfaensis** Léveillé & Vaniot.

HOLOTYPE: Between Jianfugong and Tianshidong, Qingchengshan, Guan Xian, Sichuan, China, R.-y. Zheng and R.P. Korf, 16.ix.1981, on leaf blades of **Rubus pinfaensis** Léveillé & Vaniot (CUP-CH 2346) (ISOTYPES to be issued in Korf & Gruff, Discomycetes Exsiccati).

LAMBERTELLA SUBRENISPORA Korf & Zhuang, sp. nov.

FIG. 2

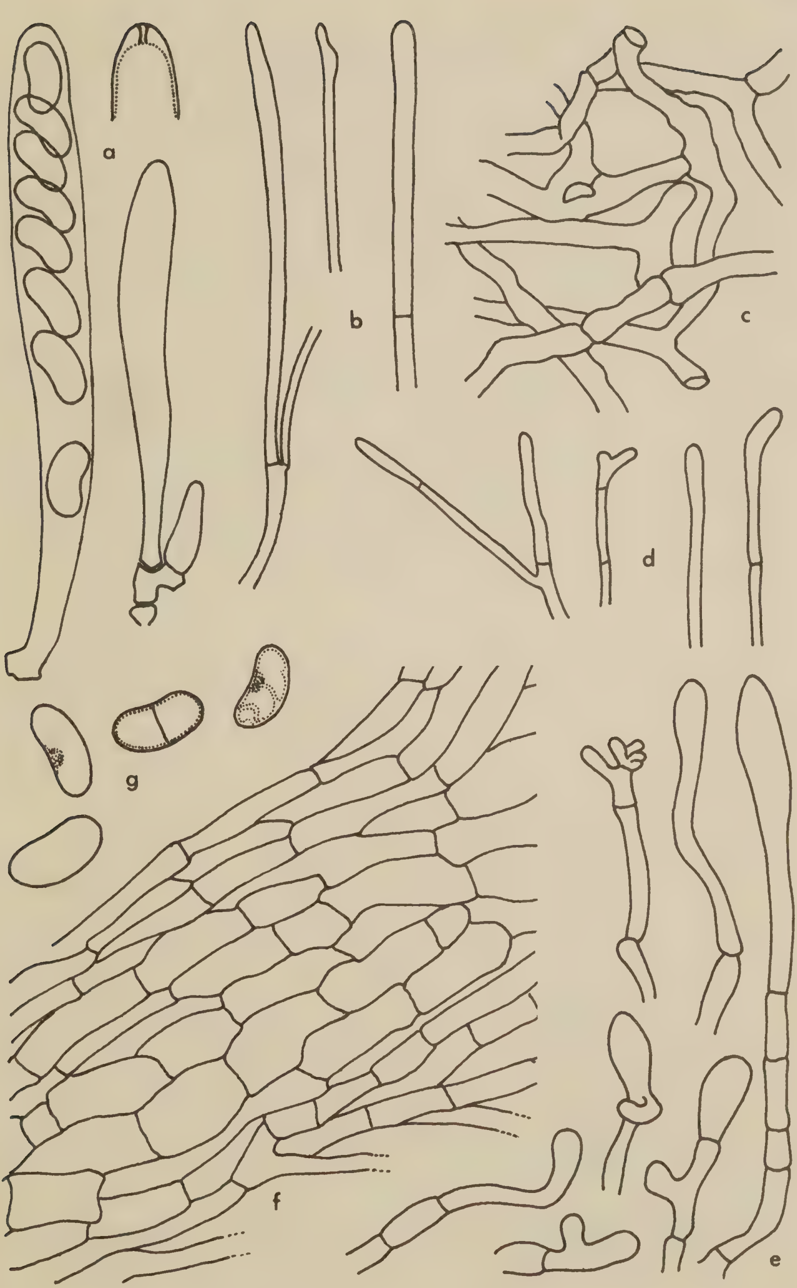
Ab Lambertellae speciebus aliis ascosporis subreniformibus aream centralem saturate tingi potentem cytoplasmatis irregulariter guttulati vel spumosi continentibus et sporae parietem hyalinum usque ad emissionem conservantibus differens.

Apothecium discoid, substipitate to short-stipitate, up to 2 mm in diam and 1.0-1.5 mm high; when rehydrated, pale vinaceous grey to purplish grey, when fresh "light pink" (Arendholz & Sharma, 1984), receptacle lighter than or concolorous with the hymenium surface, darker at the stipe base, receptacle surface downy, with whitish hairs. **Excipulum** not turning blue in Melzer's Reagent; **ectal excipulum** of textura prismatica, cell walls slightly refractive, subhyaline, sometimes brownish towards the margin, smooth, inner layer and outer covering layer present; **medullary excipulum** of textura intricata, hyphae 3.5-4.5 µm broad, loosely interwoven, walls slightly refractive, subhyaline and smooth; crystals present at the stipe base. **Hairs** growing from outer covering layer, usually with swollen apices, sometimes (particularly at the flanks) with branched apices, near the margin filiform and with cylindrical or swollen apices, septate, walls smooth, subhyaline to slightly pigmented apically. **Hymenium** about 100 µm thick; **subhymenium** indistinguishable from the medullary excipulum. **Asci** cylindrical to clavate, arising from repeating croziers, apex thick, pore walls J- in Melzer's Reagent without KOH-pretreatment, but J+ and turning strongly blue in Melzer's Reagent after 10% KOH-pretreatment, 8-spored, 80-95 X 8.0-9.5 µm, sporiferous part 41-67 µm long. **Ascospores** subreniform, hyaline within asci, becoming brown and faintly punctate after discharge, very rarely 1-septate, with a subcentral, strongly staining area in the cytoplasm (nucleus?) both in cotton blue and in phloxine, irregularly guttulate to spumose, mostly uniseriate, some partially biseriate, 11.0-13.0 X 4.8-6.4 µm. **Paraphyses** filiform, sometimes apically enlarged and slightly deformed, exceeding asci 15-10 µm.

On stems of **Artemisia** sp., **Aster ageratoides** Turcz. var. **ovatus** Nakai (Japan), and unidentified Rosaceae (India).

HOLOTYPE: Fujimi-mura, Mt. Akagi, Gumma Pref., Honshu, Japan, IMC3 Discomycete Workshop collectors,

FIG. 2. **Lambertella subrenispora**, drawn from the holotype (CUP-JA 3664) with the aid of a drawing tube, X1000. **a.** asci and ascus apex showing pore channel blue in iodine; **b.** apices of paraphyses; **c.** tissue of the medullary excipulum; **d.** hair apices from margin; **e.** hairs at the flanks; **f.** ectal excipulum showing covering layer giving rise to hairs; **g.** ascospores.


a
b
c
d
g
f
e

24.viii.1983, on **Artemisia** sp. (CUP-JA 3664) (ISOTYPES to be issued in Korf & Gruff, Discomycetes Exsiccati).

PARATYPES: (1) Akagi Shrine, Gumma Pref., Honshu, Japan, IMC3 Discomycete Workshop collectors, 24.viii. 1983, on **Aster ageratoides** var. **ovata** (CUP-JA 3663); cultures were generously made in Japan by Dr. Linda M. Kohn, University of Toronto, Mississauga, Ont., Canada, and are on deposit in the ATCC and CBS culture collections. (2) Angiospermous hedges in the forest, along road side, Samana, Darjeeling (West Bengal), India, R. Sharma, 27.viii.1980, on unidentified Rosaceae (CUP-IN 613 = PAN 17438 = Arendholz 1982-305).

NOTES: The paratype from India has somewhat longer and thinner stipes than the Japanese collections. Neither Arendhold and Sharma (1984) (who described and illustrated this species as "**Lambertella** Taxonomic sp. I") nor we could find any brown ascospores in the Indian material. They did not note either the subreniform shape of the ascospores (which they termed "ellipsoid to cylindrical") or the deeply staining "nuclear" area in the ascospores, but these are evident in their material.

TAXON NUMBERS USED IN THE SYNOPTIC KEY TOGETHER WITH THE LITERATURE SOURCES USED IN PREPARATION OF THE KEYS, WHEREIN FULL DESCRIPTIONS CAN BE FOUND

1. **Lambertella acuminata** Dumont (1971)
2. **L. agaricicola** (Berk. & Br.) Dumont (1971)
3. **L. albida** (Gillet) Korf (1982, no description); see White (1944, as **Helotium albidum** (Rob. ex Desm.) Pat.); Dennis (1956, as **Helotium robergei** Dennis)
4. **L. aurantiaca** Tewari & Pant (1967); see Thind & Singh (1970, as **L. cryptomeriae** Thind & Singh); Dumont (1971, described also as **L. bonahawensis** Dumont; 1974a, three species names synonymized)
5. **L. belisensis** (Kanouse) Dumont (1974a, notes only); see Kanouse (1941, as **Helotium belisense** Kanouse); Dennis (1959 as **L. boliviana** Dennis; 1964 as **Rutstroemia belisensis** (Kanouse) Dennis); Dumont (1971, as **L. boliviana**)
6. **L. berberidis** Elliott & Sharma (1976); see Dumont (1976)
7. **L. bonahawensis** Dumont sensu Gautam & Pant (1982) [not **L. aurantiaca** Tewari & Pant emend. Dumont in our opinion]

8. L. **bonahawensis** var. **tomentosa** Gautam & Pant (1982)
9. L. **bouchetii** Grelet (1948); (description verbatim in Dumont, 1971)
10. L. **brunneola** (Pat.) Le Gal (1953); see Dumont (1971)
11. L. **buchwaldii** Tewari & Singh (1972)
12. L. **carpatica** Svrček (1976)
13. L. **cephalanthi** Whetzel & Dumont in Dumont (1971)
14. L. **copticola** Korf & Tewari in Tewari (1963); see Dumont (1971)
15. L. **corni-maris** Höhnel; see Dumont (1971)
16. L. **crystallina** Gautam, Das, Pant & Tewari (1982)
17. L. **fructicola** Dumont (1971); see Dumont (1974a, synonymy); Tewari & Pant (1967); Tewari & Singh (1972, as L. **kumaonica** Tewari & Singh)
18. L. **fusco-tomentosa** Tewari and Singh (1974)
19. L. **garryae** (Cash) Dumont (1971); see Cash (1958, as **Phaeociboria garryae** Cash)
20. L. **himalayensis** Tewari & Pant (1967); see Dumont (1971)
21. L. **jasmini** Seaver, Whetzel & Dumont in Dumont (1971)
22. L. **lasseri** (Dennis) Dumont (1981); see Dennis (1960, as **Helotium lasseri** Dennis)
23. L. **makilingensis** Dumont (1971)
24. L. **malesiana** Dumont (1971)
25. L. **mexicana** Dumont (1971)
26. L. **microspora** (Seaver) Dumont (1974b, notes); see Seaver (1925, as **Phialea microspora** Seav.); Dumont (1971, as L. **pallidispora** Dumont)
27. L. **minutula** (Whetzel) Dumont (1975); see Whetzel (1944, as **Coprotinia minutula** Whetzel)
28. L. **mussooriensis** Thind & Singh (1972)
29. L. **myricae** Dennis & Spooner in Dennis, Reid & Spooner (1977)
30. L. **nipponica** Dumont & Korf in Dumont (1971)
31. L. **pachysandra** Dumont & Korf in Dumont (1971)
32. L. **pruni** Whetzel, Zeller & Dumont in Dumont (1971)
33. L. **pseudostriata** Dumont (1971)
34. L. **rhamnicola** (Batra) Dumont (1971); see Batra (1968, as **Phaeodiscus rhamnicola** Batra)
35. L. **spadiceo-atra** (Mont.) Dumont (1981, no description); see Dennis (1964, as **Hymenoscyphus spadiceo-ater** (Mont.) Dennis); Dumont (1971, as L. **phaeoparaphysata** Dumont; 1974a, as L. **chromo-flava** (Rick) Dumont)
36. L. **tetrica** (Quélet) Dumont (1971)

37. L. **tewarii** Dumont (1971)
38. L. **thindii** Dumont (1976)
39. L. **tropicalis** (Kanouse) Whetzel; see Kanouse (1941, as **Ciboria tropicalis** Kanouse); Dumont (1971)
40. L. **tubulosa** Abdullah & Webster (1981)
41. L. **venezuelensis** Dumont (1971)
42. L. **viburni** Whetzel & Dumont in Dumont (1971)
43. L. **whetzelii** Gautam, Das, Pant & Tewari (1982)
44. L. **zeylanica** Dumont (1971)
45. **Phaeociboria brasiliensis** H. Sydow (1921); (description verbatim in Dumont, 1971)
46. L. **rubi** Korf & Zhuang, **sp. nov.** (this paper)
47. L. **subrenispora** Korf & Zhuang, **sp. nov.** (this paper)

HOST INDEX (NOT USED IN THE KEY)

ACER	**L. tubulosa**
Agaricaceae	**L. agaricicola**
ARCHONTOPHOENIX	**L. microspora**
ARTEMISIA	**L. subrenispora**
ARTOCARPUS	**L. microspora**
ASTER	**L. subrenispora**
ASTRONIA	**L. makilingensis**
BERBERIS	**L. berberidis**
	L. fructicola
CALOPHYLLUM	**L. zeylanica**
CARYA	**L. corni-maris**
CEPHALANTHUS	**L. cephalanthi**
CITHAREXYLUM	**L. jasmini**
COCCOLOBIS	**L. tropicalis**
COPTIS	**L. copticola**
CORNUS	**L. corni-maris**
	L. jasmini
CRYPTOMERIA	**L. aurantiaca**
CYTTARIA	**L. corni-maris**
DALBERGIA	**L. pseudostriata**
	L. tewarii
DAMNACANTHUS	**L. nipponica**
ELAEOCARPUS	**L. makilingensis**
ERIOBOTRYA	**L. jasmini**
EUGENIA	**L. whetzelii**
EUPHORBIA	**L. carpatica**
EUTERPE	**L. microspora**
FRAXINUS	**L. albida**
GARRYA	**L. garryae**
GUNNERA	**L. spadiceo-atra**
Guttiferae	**L. acuminata**
HEDERA	**L. tetrica**
ILEX	**L. belisensis**
	L. mussooriensis
IXORA	**L. acuminata**
JASMINUM	**L. jasmini**
	L. tewarii
MADHUCA	**L. aurantiaca**
MAESA	**L. nipponica**
MALUS	**L. corni-maris**
MANGIFERA	**L. aurantiaca**
Melastomataceae	**L. lasseri**
	L. makilingensis
MYRICA	**L. myricae**
Myrtaceae	**L. belisensis**
	L. spadiceo-atra
PACHYSANDRA	**L. pachysandra**
Palmae	**L. microspora**
PINUS	**Ph. brasiliensis**
PRUNUS	**L. jasmini**
	L. pruni
PYRUS	**L. corni-maris**
	L. fructicola
QUERCUS	**L. fructicola**
	L. himalayensis
RHAMNUS	**L. rhamnicola**
ROSA	**L. fructicola**
Rosaceae	**L. subrenispora**
RUBUS	**L. rubi**
SHOREA	**L. buchwaldii**
VIBURNUM	**L. fructicola**
	L. thindii
	L. viburni

SYNOPTIC KEY (1985) TO THE SPECIES OF LAMBERTELLA

Enter the key at any appropriate point. (See page 383 for one suggested character choice order, that used in our current TAXADAT "auto-search.") Taxa with numbers in **bold face** have that character state only; those in roman face have more than one possible character state; for those in parentheses, the character state is undescribed and as yet unknown. Characters are listed in 7 major groups: **fruitbody** characters, **hair** characters, **ascus** characters, **ascospore** characters, **paraphysis** characters, **excipular** characters, and **substrate.**

FRUITBODY CHARACTERS

1-1 Apothecial shape
- a. discoid to cupulate 2 4 6 7 8 9 10 11 12 13 14 15 **16** 17 18 20 21 **22** 23 24 26 28 31 33 34 38 40 42 45 46 **47**
- b. flat 1 2 **3** 4 5 6 7 8 9 10 11 13 14 15 17 18 19 20 21 23 24 25 26 28 **29** **30** 31 32 33 34 **35** 36 37 38 **39** 40 **41** 42 43 **44** 45 46
- c. convex 1 2 5 7 8 15 17 23 25 26 28 31 32 36 37 38 40 43
- d. recurved **27**

1-2 Apothecial diameter
- a. less than 1 mm **10** **13** 21 26 29 32 **34** 35 37 40 42 **46**
- b. 1 to 2 mm 2 **3** 4 **5** 6 **12** 14 15 17 **19** 21 **22** 23 **25** 26 **27** 29 30 31 32 33 35 **36** 37 **39** 42 **44** **47**
- c. 2 to 5 mm 1 2 4 6 **7** 8 **9** 11 14 15 **16** 17 18 **20** 21 23 **24** 26 30 31 33 **41** 45
- d. more than 5 mm 15 **28** **38** **43**

1-3 Apothecium plus stipe height
- a. less than 1 mm (1) 2 6 10 15 **19** 21 **22** **24** **25** **29** **32** 33 **36** (37) 39 (40) (44) 45
- b. 1 to 2 mm (1) 4 5 7 8 10 11 12 13 15 17 **20** 21 **23** **26** 31 33 **34** **35** (37) 39 (40) 41 (44) 45 **46** **47**
- c. 2 to 3 mm (1) **3** 4 5 **9** 11 12 15 **16** 17 21 31 (37) (40) (44) 45
- d. more than 3 mm (1) 4 11 **14** 15 17 **18** **27** **28** **30** 31 (37) **38** (40) **42** **43** (44) 45

1-4 Apothecial margin
- a. crenate or dentate 5 **11** **12** **35**
- b. even or not noticed (all taxa except 11 12 35)

1-5 **Hymenium color when fresh**
- a. white to pallid **3** 11 15 **22** 23 26 29 (33) (36) 38 **39** 40 (46) (47)
- b. cream/yellow/orange/golden 1 4 **18** 21 23 **28** (33) (36) 38 40 (46) (47)
- c. beige to medium brown 1 4 5 6 **8** **9** **10** 11 **12** 13 **14** 15 17 21 23 **24** **25** 26 27 30 31 **32** (33) **34** 35 (36) 37 **41** 42 **44** **45** (46) (47)
- d. pinkish to reddish brown 4 11 23 26 29 30 31 (33) 35 (36) (46) (47)
- e. vinaceous brown **2** 17 23 (33) 35 (36) 37 42 (46) (47)
- f. olivaceous brown 4 **7** 17 **19** 20 21 (33) (36) (46) (47)
- g. grey **16** (33) (36) **43** (46) (47)
- h. dark brown to nearly black 4 5 6 11 13 17 20 27 (33) (36) 42 (46) (47)

1-6 **Hymenium color when dry**
- a. white to pallid (3) (9) (10) (11) (12) 23 26 (27) (28) (29) (40) (43) (45)
- b. cream/yellow/orange/golden (3) (9) (10) (11) (12) 13 23 26 (27) (28) (29) 33 (40) 41 (43) (45)
- c. beige to medium brown **2** (3) (9) (10) (11) (12) 14 23 25 (27) (28) (29) 30 **39** (40) 41 (43) 44 (45)
- d. pinkish to reddish brown **1** (3) **5** (9) (10) (11) (12) 13 **18** **22** **24** (27) (28) (29) 30 **31** 33 37 38 (40) (43) (45)
- e. vinaceous brown (3) (9) (10) (11) (12) 14 (27) (28) (29) 35 37 (40) (43) (45) **46** 47
- f. olivaceous brown (3) (9) (10) (11) (12) 14 19 (27) (28) (29) (40) (43) (45)
- g. grey (3) (9) (10) (11) (12) **16** (27) (28) (29) (40) (43) (45) 47
- h. dark brown to nearly black (3) **4** **6** **7** **8** (9) (10) (11) (12) **15** **17** 19 **20** **21** 25 (27) (28) (29) **32** **34** 35 **36** 38 (40) 41 **42** (43) 44 (45)

1-7 **Receptacle color when fresh**
- a. white to pallid (2) (3) (8) 11 15 20 **22** 23 26 (27) (29) 32 (33) (36) 38 **39** (46) (47)
- b. cream/yellow/orange/golden (2) (3) 4 **7** (8) **14** **18** 21 23 (27) **28** (29) (33) (36) 38 **40** (46) (47)
- c. beige to medium brown (2) (3) 5 6 (8) 9 **10** 11 **12** 13 15 17 23 **24** **25** 26 (27) (29) 30 32 (33) **34** 35 (36) 37 **41** **42** **44** **45** (46) (47)

d. pinkish to reddish brown (2) (3) 4 (8) 11 15 20 23 26 (27) (29) 30 31 32 (33) 35 (36) 37 (46) (47)
e. vinaceous brown (2) (3) (8) 17 20 (27) (29) 32 (33) 35 (36) 37 (46) (47)
f. olivaceous brown (2) (3) (8) 17 19 21 23 (27) (29) (33) (36) (46) (47)
g. grey (2) (3) (8) 16 (27) (29) (33) (36) 43 (46) (47)
h. dark brown to nearly black 1 (2) (3) 5 6 (8) 9 15 (27) (29) (33) (36) (46) (47)

1-8 Receptacle surface
a. smooth 3 4 5 7 8 9 10 15 17 23 24 26 27 28 33 34 38 39 (40) 41 43 (45)
b. furfuraceous or pruinose 1 4 6 11 12 15 16 17 19 20 21 22 23 24 25 26 29 32 34 35 36 37 38 39 (40) 41 42 (45) 47
c. hairy/woolly/tomentose 2 8 13 14 15 18 19 30 31 36 (40) 42 44 (45) 46

1-9 Stipe presence
a. absent or very short 2 4 6 19 22 29 32 36 39 40 41 47
b. obviously present (all taxa except 2 6 19 22 29 32 36 40 41)

1-10 Stipe base constriction
a. constriction obvious 9 13 24 25 32 33 37 39 41 43 44
b. absent or not noticed (all taxa except 13 24 25 33 37 39 41 43 44)

1-11 Stipe surface
a. smooth (2) 4 5 7 9 10 15 16 17 20 24 27 28 33 34 (38) 39 (40) 41 42 (43) (45)
b. furfuraceous or pruinose 1 (2) 3 4 6 11 12 15 16 17 19 20 22 23 24 25 26 28 29 31 32 35 36 37 (38) (40) 41 42 (43) (45) 46 47
c. hairy/wooly/tomentose (2) 8 13 14 15 18 21 30 (38) (40) 42 (43) 44 (45)

1-12 Presence of crystals
a. at stipe base 16 47
b. at margin of disc 12
c. not noticed (all taxa except 12 16 47)

HAIR CHARACTERS

2-1 Apices of hairs or hyphal protrusions
- a. expanded at apex 2 3 4 6 (8) (9) 11 (12) 14 15 (16) (18) 19 (20) 21 24 25 (28) (29) 32 34 (35) 36 37 (40) 42 (45) 46 47
- b. tapered towards apex 1 5 (8) (9) 10 (12) 13 14 (16) (18) (20) 23 26 (28) (29) 30 31 33 (35) 36 37 38 (40) 41 43 44 (45)
- c. neither expanded nor tapered 1 4 5 (8) (9) 10 (12) 13 (16) (18) 19 (20) 21 22 23 26 (28) (29) 30 32 33 (35) 36 37 38 (40) 41 43 (45) 46 47

2-2 Hair roughening
- a. smooth 2 (3) 4 5 (6) 8 (9) 10 (11) (12) 13 14 15 (16) (18) 19 (20) 21 22 24 (28) (29) 30 31 32 34 (35) 36 37 38 (40) 42 44 (45) 47
- b. roughened 1 2 (3) 4 (6) (9) 10 (11) (12) 15 (16) (18) 19 (20) 23 24 25 26 (28) (29) 32 33 (35) 37 (40) 41 42 43 44 (45) 46

2-3 Hair pigmentation
- a. hyaline or subhyaline (3) 4 5 6 8 (9) 10 11 (12) 13 14 15 16 17 21 22 24 25 (28) (29) 30 (31) 32 34 (35) 36 37 38 (40) 41 42 44 (45) 47
- b. pigmented 1 2 (3) 4 5 7 (9) 10 (12) 13 14 15 16 18 19 21 23 25 26 (28) (29) (31) 32 33 34 (35) 36 37 (40) 42 43 (45) 46 47

ASCUS CHARACTERS

3-1 Spore number per ascus
- a. four (or only 4 mature) 12 19 20 23 24 37 39
- b. eight (all taxa except 12 20 23 24)

3-2 Ascus pore iodine reaction *(use oil immersion!)*
- a. turning blue 1 2 3 4 5 7 8 11 12 13 14 15 16 17 18 20 21 23 24 25 26 27 28 29 30 31 32 33 37 38 39 (40) 41 42 43 44 45 46 47
- b. not turning blue 1 4 5 6 9 10 12 14 16 17 19 20 21 22 23 24 25 27 28 31 34 35 36 37 (40) 42 43 44 45 47

3-3 Ascus: total length (apex to basal septum)
- a. less than 80 microns 1 4 5 7 8 12 16 18 22 23 24 25 26 27 30 35 40 41 42 43 44 (45) 46

b. 80 to 100 microns **2 3** 4 6 7 8 10 12 13 14 15 17 18 20 21 22 23 25 **29** 30 33 36 37 38 39 41 42 (45) **47**
c. more than 100 microns 6 **9** 10 **11** 13 14 15 17 19 20 21 **28 31 32** 33 **34** 36 37 38 39 42 (45)

3-4 Ascus: length of sporiferous part only
a. less than 40 microns 1 (3) 4 5 (7) (8) (9) (10) (11) (12) 13 (18) (19) (22) 24 **26 27** (28) (29) 35 37 (38) (40) (43) **44**
b. 40 to 60 microns 2 (3) 4 5 (7) (8) (9) (10) (11) (12) 13 14 15 **16** (18) (19) 20 21 (22) **23** 24 25 (28) (29) 30 31 35 37 (38) (40) 41 42 (43) **45 46** 47
c. more than 60 microns 2 (3) 5 **6** (7) (8) (9) (10) (11) (12) 13 14 15 **17** (18) (19) 20 21 (22) 25 (28) (29) 30 31 **32 33 34 36** 37 (38) **39** (40) 41 42 (43) 47

3-5 Ascus width
a. less than 7 microns 1 **2** 4 **7** 8 **12** 15 16 20 21 24 25 **26 27** 35 37 **43 44 45 46**
b. 7 to 10 microns 4 **5 9** 10 13 14 15 16 17 18 20 21 22 **23** 24 25 28 29 30 33 34 36 37 38 39 40 41 42 **47**
c. 10 to 15 microns **3** 6 10 11 13 14 17 18 **19** 22 28 29 30 **31 32** 33 34 36 38 39 42
d. more than 15 microns 6 14

ASCOSPORE CHARACTERS

4-1 Spore shape
a. subglobose/broadly ellipsoid 1 4 5 9 13 17 19 20 21 22 23 35 40 43 44
b. subellipsoid to ellipsoid 2 **3** 4 5 6 **7** 8 9 10 12 13 **15 16** 17 20 21 22 23 24 26 **27** 29 30 31 34 35 **38** 39 40 41 42 43 44 45 46 47
c. subfusoid to elongate-fusoid 2 4 5 6 9 10 12 13 **14** 18 19 20 23 24 **25** 26 **28** 30 31 **34** 35 36 **37** 39 40 41 42 46
d. subreniform to allantoid 12 36 39 47
e. lunate to broadly lunate 6 32
f. slipper-shaped/almond-shaped 5 11

4-2 Spore with one end broader
a. present 1 2 3 **19 20** 23 **27 31 32** 44 46
b. absent (all taxa except 1 3 19 20 23 27 31 32)

4-3 Spore flattening on one side
- a. present 1 2 3 4 5 6 (7) (8) (9) 10 11 12 13 14 15 (16) 17 18 19 20 21 22 23 25 26 (27) (28) (29) 31 32 34 35 36 37 39 (40) 41 (42) (43) 44 (45) 47
- b. absent 1 2 3 4 5 (7) (8) (9) 11 13 (16) 18 22 23 24 26 (27) (28) (29) 30 31 33 35 38 (40) 41 (42) (43) (45) 46

4-4 Spore color within normal asci
- a. hyaline at discharge (3) 4 5 8 10 11 12 13 14 15 18 22 23 24 26 28 29 30 31 37 38 40 42 44 46 47
- b. pigmented at discharge 1 2 (3) 4 6 7 9 10 12 16 17 19 20 21 24 25 26 27 28 32 33 34 35 36 39 40 41 42 43 45
- c. both hyaline and colored in same ascus (3) 4 15 19 20 21 25 26 33 35 36 39 40 41

4-5 Spore walls
- a. punctate (dotted) 1 2 (3) 4 5 6 7 8 (9) 10 (11) (12) 13 14 15 16 17 18 19 20 21 22 24 25 (27) (28) (29) 30 31 34 35 36 37 38 39 (40) 42 44 (45) 47
- b. banded (one side darker) 1 (3) 6 (9) 10 (11) (12) 14 15 17 25 (27) (28) (29) 30 31 32 36 37 38 (40) 41 44 (45) 46
- c. striate or pseudostriate (3) (9) (11) (12) (27) (28) (29) 33 (40) 41 (45)
- d. not as above (uniform color) 1 (3) 5 (9) (11) (12) 22 23 24 26 (27) (28) (29) 30 38 (40) 41 42 43 (45) 46 47

4-6 Spore guttulation
- a. nonguttulate 2 12 15 19 39 42
- b uniguttulate 3 6 9 11 20 34 45
- c. biguttulate 1 4 5 6 7 8 9 10 13 14 15 16 17 18 20 21 22 23 24 25 26 27 28 29 30 31 32 34 35 37 38 40 42 43 44 46
- d. 3-guttulate 5 9 10 14 20 24 25 28 31 33 34 35 46
- e. multiguttulate to spumose 6 10 14 15 23 24 25 28 31 33 36 39 41 47

4-7 Spore seriation
- a. mostly uniseriate 1 2 4 5 6 7 8 9 10 11 12 13 15 16 17 19 20 21 22 23 24 27 32 33 35 37 39 40 43 45 46 47

b. mostly biseriate 5 10 13 14 18 25 26 27 30 31 34 35 36 40 41 44
c. mostly mixed or irregularly seriate 3 5 13 14 22 27 28 29 34 35 37 38 40 42 46

4-8 Spore length
a. less than 6 microns 1 26 27 44
b. 6 to 10 microns 1 2 4 5 7 8 10 12 13 15 16 21 22 23 26 30 35 37 40 42 43 44 45 46
c. 10 to 15 microns 2 3 4 5 9 10 11 12 13 14 15 17 18 19 20 21 22 23 24 25 29 30 32 33 34 37 38 39 41 42 47
d. more than 15 microns 3 4 6 10 13 14 17 19 20 23 24 25 28 31 32 33 34 36 37 38 39 41 42

4-9 Spore width
a. less than 3 microns 1 14 26 27 35 43 44 46
b. 3 to 5 microns 1 2 3 4 5 7 8 10 12 13 14 15 16 17 18 21 22 23 24 25 26 28 29 30 31 34 35 36 37 38 39 40 41 42 43 44 45 47
c. more than 5 microns 6 9 10 11 12 13 15 17 19 20 21 23 31 32 33 34 37 39 40 41 42 47

PARAPHYSIS CHARACTERS

5-1 Paraphysis uniformity
a. two types present 1 35
b. only one type present (all other taxa)

5-2 Paraphyses exceeding asci
a. slightly or not at all 1 2 (3) 4 5 6 (7) (8) (9) 10 12 13 14 15 (16) 17 (18) 19 20 21 22 23 24 25 26 28 29 30 31 32 33 35 37 39 40 41 42 44 (45) 46
b. obviously (10 microns or more) (3) (7) (8) (9) 11 14 (16) (18) 25 34 36 38 43 (45) 47

5-3 Paraphysis branching at apex
a. branched 1 4 14 17 42
b. absent or at least not noticed (all taxa except 1 14)

5-4 Paraphysis shape
a. knobbed at apex 10 35 41
b. tapered towards apex 1 34 36 38
c. cylindrical or slightly expanded at apex (all taxa except 34 38 41)

EXCIPULAR CHARACTERS

6-1 Iodine reaction of ectal excipular, medullary excipular, or subhymenial tissues
   a. turning blue 1 (2) (3) 4 (7) (8) (9) (11) 12 (16) 17 (18) 20 21 (22) 26 (27) (28) (29) 32 (38) 39 (43) (45)
   b. not turning blue (2) (3) 4 5 6 (7) (8) (9) 10 (11) 13 14 15 (16) (18) 19 20 (22) 23 24 25 26 (27) (28) (29) 30 31 33 34 35 36 37 (38) 40 41 42 (43) 44 (45) 46 47

6-2 Medullary excipulum refraction
   a. refractive 1 (3) 5 (6) 7 (9) 10 (11) (12) (13) (16) (17) 18 26 (27) (28) (29) 31 34 39 (40) (43) (45) 47
   b. not refractive 2 (3) 4 5 (6) 7 8 (9) (11) (12) (13) 14 15 (16) (17) 18 19 20 21 22 23 24 25 26 (27) (28) (29) 30 31 32 33 35 36 37 38 (40) 41 42 (43) 44 (45) 46 47

6-3 Medullary excipulum wall color
   a. hyaline to subhyaline 1 (3) 4 6 7 (8) (9) 10 (11) (12) 13 14 16 (17) 18 19 20 21 22 23 24 25 26 27 (28) (29) 33 (34) 36 37 38 39 40 (43) 44 (45) 46 47
   b. pigmented 2 (3) 4 5 6 (8) (9) (11) (12) 13 15 (17) 19 21 22 23 25 26 27 (28) (29) 30 31 32 33 (34) 35 36 37 38 41 42 (43) (45)

6-4 Medullary excipulum wall roughening
   a. smooth 1 2 (3) 4 6 (7) (8) (9) 10 (11) (12) 13 14 15 (16) (17) (18) 19 21 22 23 24 25 26 27 (28) (29) 36 37 38 39 (40) (43) 44 (45) 46 47
   b. roughened (3) 5 (7) (8) (9) (11) (12) 13 15 (16) (17) (18) 19 20 21 23 25 26 27 (28) (29) 30 31 32 33 34 35 36 38 (40) 41 42 (43) 44 (45) 46

6-5 Medullary excipulum hyphal spacing
   a. loosely interwoven 1 (3) 4 (5) (7) (8) (9) 10 11 14 15 16 17 19 20 21 22 23 24 25 26 27 28 (29) 30 31 33 35 36 37 38 41 43 44 (45) 46 47
   b. tightly interwoven 1 2 (3) 4 (5) 6 (7) (8) (9) 13 14 16 17 18 20 22 23 25 (29) 31 32 33 34 39 40 42 (45)

6-6 Inner ectal excipular layer presence

a. present 1 (2) (3) 4 5 6 (7) (8) (9) 10 (11) (12) 13 14 15 16 (17) (18) 19 20 21 22 23 24 25 26 27 (28) (29) 30 31 32 33 34 35 36 37 38 39 (40) 41 42 (43) 44 (45) 46 47

b. not easily distinguished (2) (3) (7) (8) (9) 10 (11) (12) (17) (18) 21 27 (28) (29) 30 31 32 34 (40) (43) (45)

6-7 Inner ectal excipular wall color

a. hyaline to subhyaline 1 (2) (3) 4 6 (7) (8) (9) (10) (11) (12) 16 (17) (18) 20 24 25 27 (28) (29) 30 31 32 33 (34) 36 37 38 39 (40) (43) 44 (45) 47

b. pigmented (2) (3) 4 5 6 (7) (8) (9) (10) (11) (12) 13 14 15 (17) (18) 19 20 21 22 23 24 25 26 27 (28) (29) 30 31 32 (34) 35 36 38 (40) 41 42 (43) 44 (45) 46

6-8 Inner ectal excipular wall roughening

a. smooth (2) (3) 4 (6) (7) (8) (9) (10) (11) (12) 15 (16) (17) (18) 21 22 (28) (29) 31 32 33 (34) 36 37 38 39 (40) (43) (45) 47

b. roughened 1 (2) (3) 4 5 (6) (7) (8) (9) (10) (11) (12) 13 14 15 (16) (17) (18) 19 20 21 23 24 25 26 27 (28) (29) 30 31 32 (34) 35 38 (40) 41 42 (43) 44 (45) 46

6-9 Outer ectal excipular hyphal refraction

a. refractive 1 (3) 4 5 6 7 (8) (9) 10 (11) (12) 16 (17) 18 19 26 (27) (28) (29) 31 34 38 39 (40) 41 (43) (45) 47

b. not refractive 2 (3) 6 (8) (9) 10 (11) (12) 13 14 15 16 (17) 20 21 22 23 24 25 26 (27) (28) (29) 30 31 32 33 35 36 37 38 (40) 41 42 (43) 44 (45) 46 47

6-10 Outer ectal excipulum of *textura*

a. angularis to globulosa 5 (9) 37 39 42 44 (45)

b. prismatica 1 2 3 4 5 6 7 8 (9) 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 (45) 46 47

c. porrecta 4 (9) 14 17 28 32 34 (45)

6-11 Outer ectal excipular wall color

a. hyaline to subhyaline (3) 4 6 7 8 (9) 10 (11) 12 14 (16) (17) (18) 19 20 22 25 (27) (28) (29) 30 (32) 33 34 36 38 39 40 41 (45) 47

b. pigmented 1 2 (3) 4 5 (9) 10 (11) 12 13 14 15 (16) (17) (18) 19 20 21 23 24 25 26 (27) (28) (29) 30 31 (32) 33 34 35 36 37 41 42 43 44 (45) 46 47

6-12 Outer ectal excipular wall roughening

a. smooth 1 (3) 4 (6) (7) (8) (9) 10 (11) (12) 14 15 (16) (17) (18) 21 22 (27) (28) (29) 30 31 (32) 33 34 35 38 39 (40) 41 (45) 47

b. roughened 2 (3) 4 5 (6) (7) (8) (9) 10 (11) (12) 13 14 15 (16) (17) (18) 19 20 21 23 24 25 26 (27) (28) (29) 30 31 (32) 33 34 35 36 37 38 (40) 41 42 43 44 (45) 46

6-13 Covering layer presence

a. present 1 2 (3) 4 5 6 7 8 (9) 10 (11) 12 14 15 16 17 (18) 19 20 21 22 23 24 26 (28) (29) 30 31 32 33 34 35 36 37 38 39 (40) 41 42 (43) 44 (45) 46 47

b. absent (3) (9) (11) 13 (18) 25 27 (28) (29) 36 (40) (43) (45) 46

6-14 Covering layer wall color

a. hyaline to subhyaline (3) 4 6 8 (9) (11) 12 14 17 (18) 20 21 24 (28) (29) 30 31 32 (40) 41 42 (43) 44 (45) 47

b. pigmented 1 2 (3) 4 5 7 (9) 10 (11) 14 15 16 17 (18) 19 21 22 23 26 (28) (29) 31 32 33 34 35 37 38 39 (40) 42 (43) 44 (45) 46

6-15 Covering layer wall roughening

a. smooth (3) 4 6 (8) (9) (11) 12 14 15 (16) 17 (18) 21 22 (28) (29) 30 31 32 (40) 42 (43) 44 (45) 47

b roughened 1 2 (3) 4 5 7 (8) (9) 10 (11) 12 14 15 (16) (18) 19 20 21 22 23 24 26 (28) (29) 30 31 32 33 34 35 37 38 39 (40) 41 42 (43) 44 (45) 46

SUBSTRATE

7-1 Occurring on

a. leaves, petioles, or fronds 1 3 4 5 6 8 9 10 11 12 13 14 16 17 18 19 21 22 23 24 25 26 28 30 31 33 34 35 36 37 39 41 42 43 44 46

b. twigs or branches 4 7 8 9 11 18 20 21 22 29 31 32 38 40 47

c. herbaceous stems 20 30 31 47

d. fruits 15 17 21 32

e. cones of conifers 45
f. other fungi 2 15
g. dung 27

A MORE CONVENTIONAL MULTI-LEAD KEY

Because of the "auto-search" feature in TAXADAT, we have prepared an author-directed method of using the data set that makes up this synoptic key. It provides what we feel may be the most logical steps in identifying an unknown specimen. The order used in the computer-assisted TAXADAT version can also be used by those having access only to this printed form by following the sequence of character choices outlined below. When a character is unknown or unavailable, merely move on to the next character in sequence:

4-4	Spore color within normal asci
3-1	Spore number per ascus
4-8	Spore length
4-9	Spore width
4-3	Spore flattening on one side
4-1	Spore shape
4-2	Spore with one end broader
4-5	Spore walls
3-3	Ascus: total length
3-4	Ascus: length of sporiferous part
3-5	Ascus width
4-7	Ascospore seriation
3-2	Ascus pore iodine reaction
5-4	Paraphysis shape
5-1	Paraphysis uniformity
6-1	Iodine reaction of tissues
6-4	Medullary excipulum wall roughening
6-10	Outer ectal excipulum of textura
6-11	Outer ectal excipular wall color
6-12	Outer ectal excipular wall roughening
6-13	Covering layer presence
1-8	Receptacle surface
1-11	Stipe surface
2-3	Hair pigmentation
2-2	Hair roughening
1-4	Apothecial margin
1-9	Stipe presence
1-12	Presence of crystals
7-1	Occurring on
4-6	Spore guttulation

A RECENTLY DESCRIBED "LAMBERTELLA"

In a recent major paper a new species, **Lambertella indica** Sharma (1984), was described and illustrated. On the basis of the illustration and description of the apothecial structure, this species must surely be excluded from the genus **Lambertella.**

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摘要

根据原始描述和其它文献记录，本文提供了*Lambertella*属（柔膜菌目，核盘菌科）四十七个分类单元的纲要检索表，并讨论了使用D.E. Anderegg的计算机程序辅助检索的优越性。分布于中国的*L. rubi*以及日本和印度的*L. subrenispora*被描述为这个属的两个新种。

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A NEW SPECIES OF *PHIALOPHORA* FROM JAPAN

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ABSTRACT

A new species of *Phialophora, P. japonica* Iwatsu et Udagawa, is described and illustrated from a collection made on rotting wood in Japan.

INTRODUCTION

According to Gams and Holubová-Jechová (5), the genus *Phialophora* Medlar (1915) is characterized by possession of pigmented or hyaline colonies, weakly pigmented or hyaline, thin-walled, basitonously branched conidiophores or simple phialides, which are discrete, typically flask-shaped, with a distinct collarette, and one-celled, hyaline or slightly pigmented conidia.

Recently, one of us (T.I.) isolated a fungus, belonging to this genus, from rotting wood in Japan. Since a comparison with other species of the genus showed the isolate to be distinct, it is described herein as a new species.

TAXONOMIC PART

Phialophora japonica Iwatsu et Udagawa, sp. nov. (Figs. 1, 2).

Coloniae in agaro "potato-dextrose" lente crescentes, post 35 dies ad temperaturam 27°C 3.6 cm diametro, velutinae, leviter sulcatae radiale, griseo-olivaceae; reverso olivaceo-nigro. Exsudatum nullum et odor absens. Mycelium partim immersum vel partim superficiale, ex hyphis ramosis, olivaceis vel dilute bruneis, septatis, laevibus vel modice scabris, 1-2.5 µm crassis compositum. Conidiophora micronemata vel semi-macronemata, mononemata, erecta, ex hyphis oriunda, simplicia, olivacea vel dilute brunnea, laevia vel modice scabra, 5-50 X 2-3 µm. Cellulae conidiogenae monophialidicae, terminales vel laterales, ex hyphis statim et singulatim oriundae, vel ex conidiophoris singulatim vel divergentim oriundae, discretae, subcylindricae, gradatim attenuatae versus apicem, sub collari modice angustatae, olivaceae vel dilute brunneae, laeves vel saepe scabrae (verruculosae [sub 'SEM'], 12-40 X 2-3 µm, nonnumquam percurrenter proliferantiae; collare conspicuum, infundibuli-forme vel ureceolatum, paulo obscurum, 1.5-3 µm crassum, deinde saepe dilatatum ad 4.5 µm, 1-2.5 µm altum. Conidia unicellularia, forma variabili , plerumque pyriformia, minus plerumque subglobosa vel ellipsoidea, hilo basilari plano, pallide olivacea vel olivacea, laevia, 1.5-3.5 X 1.2-2 µm, in capitulum mucidum aggregata.

Fig. 1. *Phialophora japonica* (IFM 4703).

A-D) Phialides and conidia, photographed with Nomarski interference contrast microscopy. Bar=5 µm.

A) Phialides with conidia aggregated in a slimy head at the apex.

B) Phialides with a flared collarette.

C) Percurrent proliferation of the conidiophore through the collarette.

D) Conidia, mostly pyriform in shape.

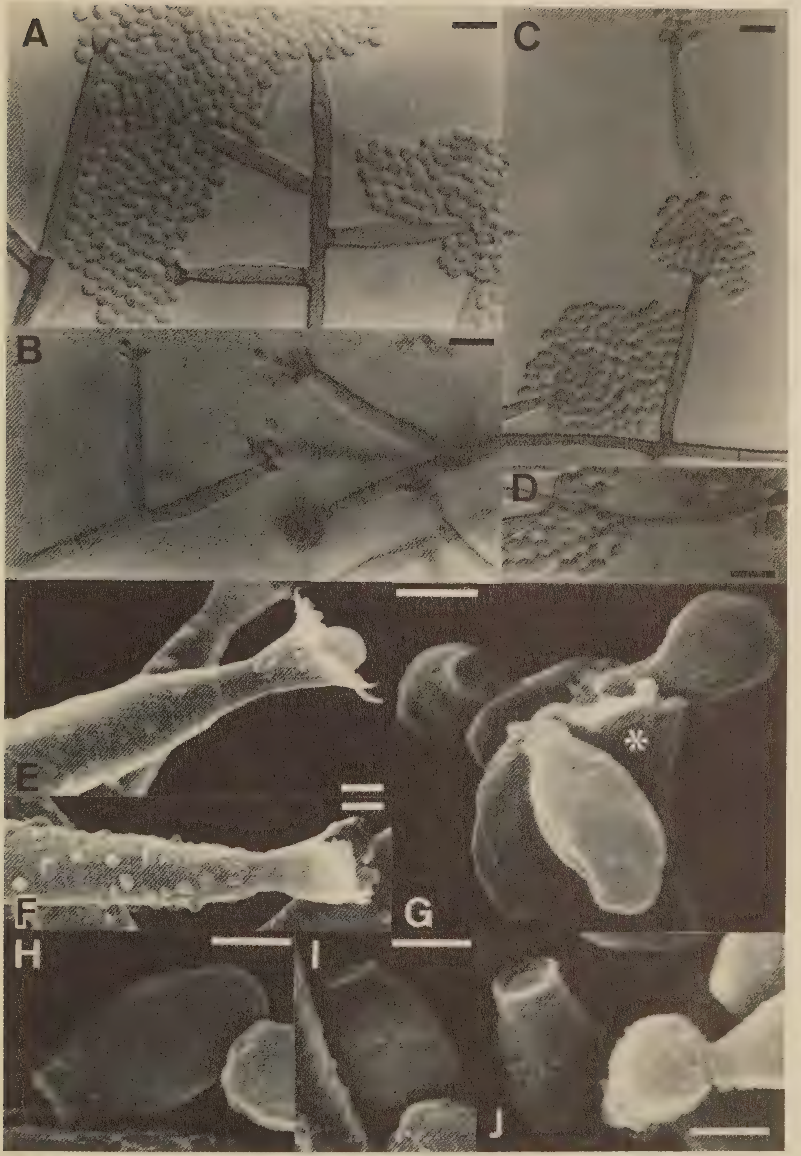
E-J) Phialides and conidia, photographed with SEM. Bar=1 µm.

E) Phialides with nearly smooth wall.

F) Phialides with verruculose wall.

G) Conidia aggregated at the apex of phialide (*).

H-J) Conidia with a distinct hilum, pyriform or ellipsoidal in shape and basally truncated.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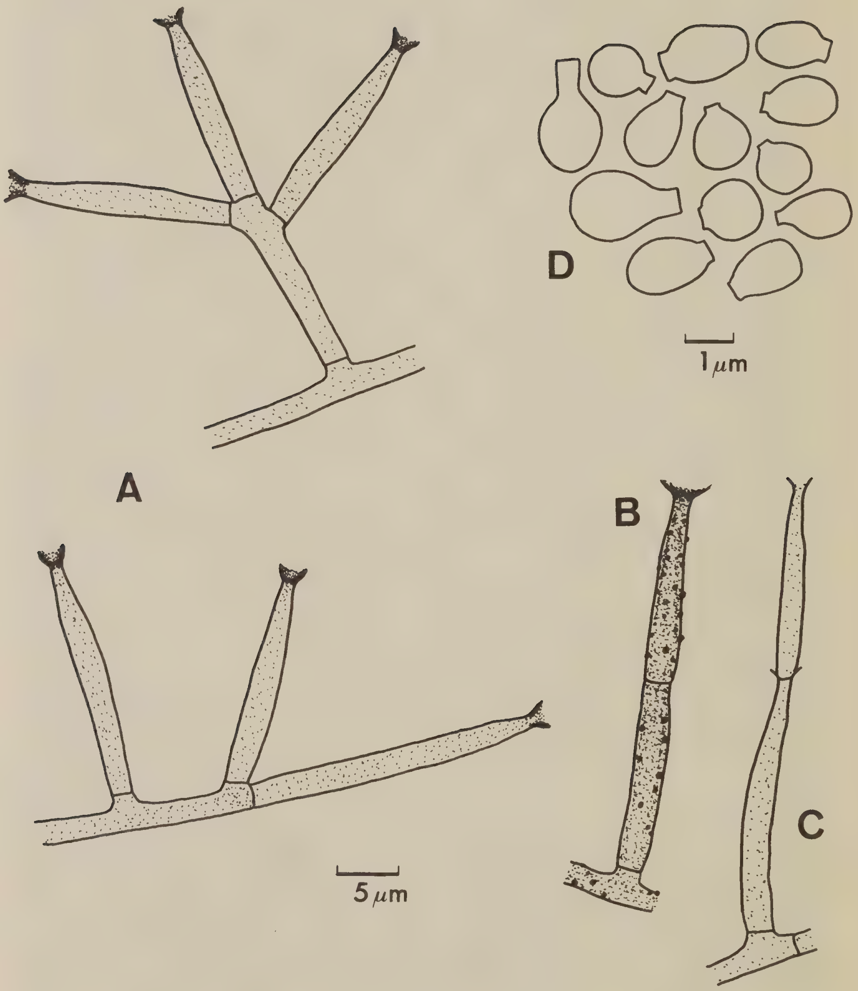

Fig. 2. *Phialophora japonica* (IFM 4703).

A-B) Conidiophores and phialides in different stages, with smooth or verruculose wall.

C) Percurrent proliferation of the conidiophore through the collarette.

D) Conidia.

Ad temperaturam 37°C, auctus absens.

Holotypus: IFM 4703 in herbarione quas 'Research Institute for Chemobiodynamics, Chiba University, Chiba, Japan'. Isolatus e ligno putrido, in Sawara, Chiba, Japonia , in 12. xii. 1978, leg. T. Iwatsu.

Etymology: Lat. *japonica*, referring to Japan, the type locality.

Colonies on potato-dextrose agar growing slowly, attaining a diameter of 3.6 cm in 35 days at 27°C, velvety, with faint radial furrows, Gray Olivaceous [Rayner, (8)]; reverse Olivaceous Black [Rayner, (8)]. Exudate and odor absent. Mycelium partly immersed or partly superficial, composed of branched, olivaceous to light brown, septate, smooth or somewhat roughened hyphae measuring 1-2.5 µm in width. Conidiophores micronematous to semi-macronematous, mononematous, erect, arising from the hyphae, simple, olivaceous to light brown, smooth or somewhat roughened, 5-50 X 2-3 µm. Conidiogenous cells monophialidic, terminal or lateral, borne directly and singly on the hyphae, or singly or in divergent forks on the conidiophores, discrete , subcylindrical, gradually tapering towards the apex and more or less constricted below the collarette, olivaceous to light brown, smooth or often roughened (verruculose under scanning electron microscopic [SEM] observation), 12-40 X 2-3 µm, sometimes proliferating percurrently; collarettes conspicuous, funnel- to vase-shaped, slightly darker, 1.5-3 µm in width, later often extending up to 4.5 µm at the flaring margin, 1-2.5 µm in depth. Conidia one-celled, variable in shape, predominantly pyriform, less commonly subglobose or ellipsoidal, with a flat basal hilum , pale olivaceous to olivaceous, smooth, 1.5-3.5 X 1.2-2 µm , aggregated in a slimy head.

At 37°C, growth is nil.

Habitat: On rotting wood.

Material examined: A dried culture of IFM 4703 (holotype) , isolated from rotting wood in Sawara, Chiba, Japan, December 12, 1978, T. Iwatsu, preserved at the Department of Pathogenic Fungi, Research Institute for Chemobiodynamics, Chiba University, Chiba, Japan. Living cultures derived from IFM 4703 are maintained at the Department of

Pathogenic Fungi, Research Institute for Chemobiodynamics, Chiba University, as DCU 426, and at National Institute of Hygienic Sciences, Tokyo, Japan, as NHL 2953.

DISCUSSION

In 1976, Gams and Holubová-Jechová (5) introduced a new section, sect. *Catenulatae* W. Gams, in the genus *Phialophora* for species producing catenate, cuneate or dacryoid conidia with a truncate base. For the remaining species having ellipsoidal or allantoid conidia, which are accumulated in a slimy head, the section *Phialophora* was reserved. The most interesting feature of *P. japonica* may be its intermediate position between these sections. Although its conidia are aggregated in a slimy head at the apex of the phialides and never catenate, they have a truncate base with a distinct hilum, characteristic of species in sect. *Catenulatae*.

Phialophora japonica is somewhat similar to *P. verrucosa* Medlar and *P. cyclaminis* van Beyma. It differs from *P. verrucosa* in the shape and size of its phialides and conidia, and its inability to grow at 37°C. *Phialophora verrucosa* is a very distinctive species with flask-shaped phialides and ovoid to ellipsoidal conidia which are slightly apiculate at the base (2, 3, 9). In addition, *P. verrucosa* usually grows well at 37°C (6). *Phialophora cyclaminis* is distinguished from our fungus by its rapid growth, broader phialides, and globose to dacryoid conidia (3, 9).

Phialophora japonica also somewhat resembles the *Phialophora* anamorphs of some Ascomycetes such as *Lasiosphaeria ovina* (Fr.) Ces. et de Not. and *Eosphaeria uliginosa* (Fr.) Höhnel, which produce pyriform to dacryoid conidia in a slimy head at the apex of phialides or in chains. The *Phialophora* anamorph of *L. ovina* differs in producing paler, ochraceous colonies, shorter, 8-15 X 2.0-2.7 µm phialides, and by lacking conspicuous collarettes (4, 5). The *Phialophora* anamorph of *E. uliginosa* produces colonies with a sweet and aromatic odor, broader, 10-25 X 3-5 µm phialides and larger, 3-5 X 2-3 µm conidia (7).

The *Chloridium* anamorph of *Chaetosphaeria myriocarpa* (Fr.) Booth, *C. clavaeforme* (Preuss) W. Gams et Hol.-Jech., is also similar to this fungus, but is more slow-growing and produces long conidiophores (1, 5). In *C. clavaeforme*, percurrent phialidic proliferation occurs more frequently.

ACKNOWLEDGEMENTS

We would like to thank Professor G. Morgan-Jones of Auburn University, Alabama, U.S.A. for reviewing the manuscript. We also thank Dr. Y. Otani for correction of the Latin diagnosis.

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A NEW SPECIES OF HETEROTHALLIC NEOSARTORYA

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SUMMARY

A new heterothallic fungus, *Neosartorya spathulata* (anamorph: *Aspergillus spathulatus*), was isolated from cultivated soil from an *Alocasia* field (*A. macrorrhiza*), Tai-Ping Village, Ilan Prefecture, Formosa. The species is characterized by light yellowish cleistothecia, bivalved ascospores with nearly smooth convex surfaces, and the production of two types of conidiophores. Besides morphological differences, it clearly differs from *N. fennelliae*, the other known heterothallic *Neosartorya*, by the incompatibility with their tester strains.

Among the cleistothecial Ascomycetes, the teleomorphs of *Aspergillus* and *Penicillium* have been considered to be primarily homothallic. There are only two exceptions, *Emericella heterothallica* (Kwon, Fennell et Raper) Malloch et Cain and *Neosartorya fennelliae* Kwon-Chung et Kim; these are described as being heterothallic (Raper and Fennell, 1965; Kwon and Raper, 1967; Malloch and Cain, 1972; Kwon-Chung and Kim, 1974). The anamorphs of these species belong to the *Aspergillus nidulans* group and the *A. fumigatus* group, respectively.

During an investigation of the mycobiota of Formosan soils by one of us (M. T.), a heterothallic fungus with an *Aspergillus* anamorph (assignable to the *A. fumigatus* group)

was isolated and appeared to be sufficiently different from *N. fennelliae* to warrant its description as a second heterothallic new species of *Neosartorya*.

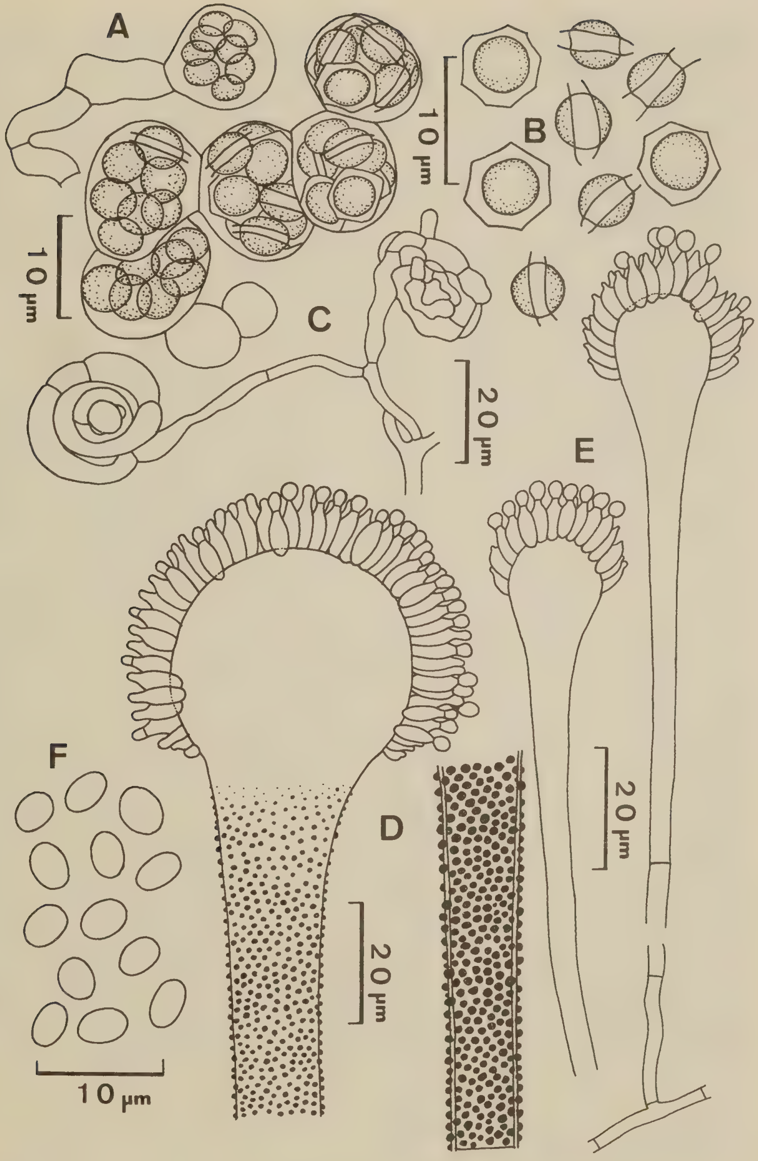
Neosartorya spathulata Takada et Udagawa, sp.nov.
(Figs. 1-6)
Stat. Anam. *Aspergillus spathulatus* Takada et Udagawa, anam. sp.nov.

Fungus heterothallicus. Cleistothecia superficialia, dispersa vel confluentia, primo alba, deinde flavescentia vel primulina vel luteola, globosa vel subglobosa, 100-260 µm diam, e filis hypharum hyalinis vel flavescentibus vestita; peridium tenue, membranaceum, pseudoparenchymatum, 'textura epidermoidea' vel 'textura angularis', e stratis duobus compositum; stratum externum e cellulis complanatis, hyalinis, irregularibus, incrassatis, 3.5-10 µm latis compositum; stratum internum e cellulis hyalinis, tenuibus, angularibus compositum. Asci octospori, irregulatim dispositi, catenati in ascogonicis hyphis, globosi vel subglobosi, 12-15.5 x 10-12 µm, postremo evanescentes. Ascosporae hyalinae, unicellulares, lenticulares, 5-7 x 3-4.5 µm, duabus cristis aequatorialibus usque 1-1.5(-2.5) µm latis praeditae, superficies convexae leves.

Mycelium e hyphis hyalinis vel flavescentibus, ramosis, septatis, granularibus, 1.5-3.5 µm latis compositum. Capitula conidica primo hemisphaerica, deinde laxe columnaria, 120-300 x 40-80 µm. Conidiophora vulgo e coacto basali vel interdum e hyphis aeriis exorientia, biformia: (a) principia magniora, plus minusve dispersa, 500-1500 x 11-18(-25) µm, supra striam secundariam capitulum protrudentia, valde verrucosa, incrassata, hyalina vel dilute flavo-brunnea, superne gradatim ampliata et (22-)25-52 µm diam vesicularia; (b) secundaria conidiophora minora, 60-250 x 4-10 µm, levia, incrassata, hyalina, superne ampliata et 8-15(-24) µm diam vesicularia. Metulae nullae. Phialides confertae, in summa 1/2-3/4 vesicula sitae, ampulliformes, 6-10 x 2-4 µm. Conidia dilute flavo-viridia, vulgo ellipsoidea, interdum subglobosa vel ovoidea, 3-5.5 x 2-4.5 µm, levia.

Coloniae in agaro Czapekii paulo lente crescentes, tenues, e mycelio vegetativo submerso constantes, sparsis conidialibus capitulis formantes, griseo-viridiae vel

Figure 1. *Neosartorya spathulata*.
A. Asci. B. Ascospores. C. Cleistothecial initials. D. Large type of conidial head. E. Small type of conidial heads. F. Conidia.


A
B
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10 µm
10 µm
20 µm
20 µm
20 µm
10 µm

griseo-venetae; reversum incolor.

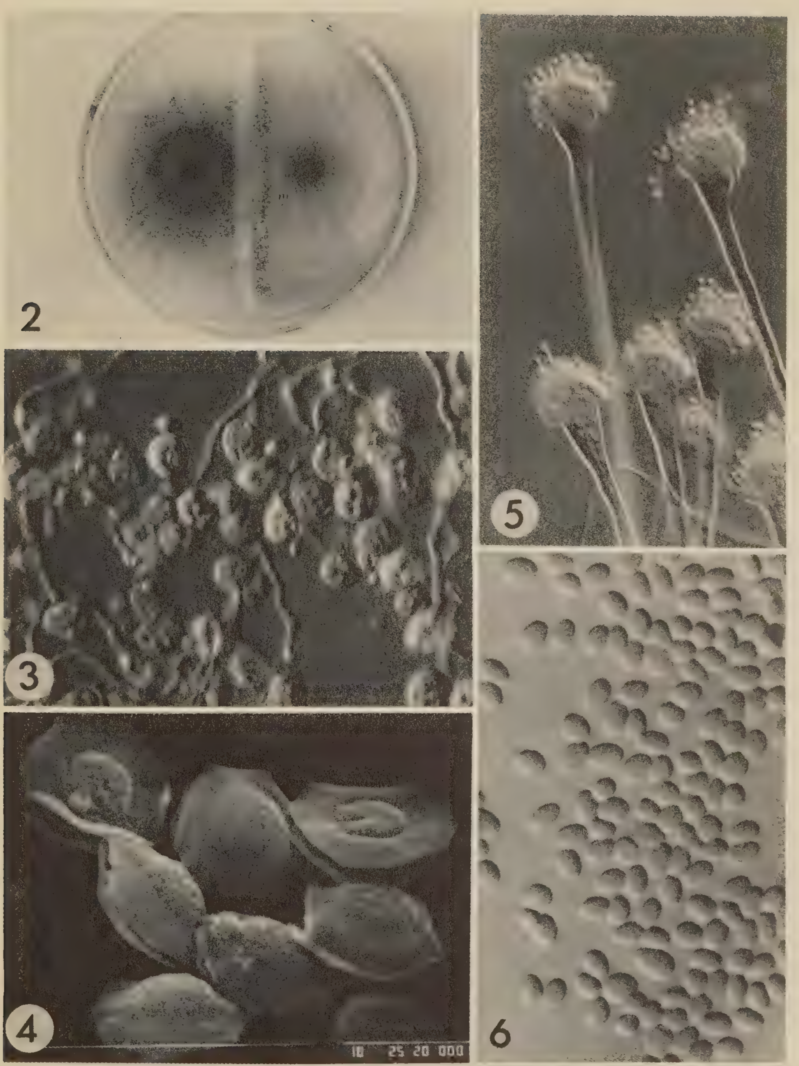
Coloniae in agaro maltoso effusae, floccosae, e mycelio tenui coacto constantes, abundantibus conidialibus capitulis formantes, obscure virides vel griseo-virides vel glauco-venetae vel pistaceae; reversum incolor vel aliquantum griseo-brunneum vel in centro coloniae hinnuleum.

Holotypus NHL 2947, colonia exsiccata ex crusi NHL 2948 x NHL 2949, uterque ex solo sativo in Tai-Ping, Ilan, Formosa, 13.x.1982, a M. Takada, isolata. In herb. NHL.

Etymology: lat. *spathulatus*, referring to spathulate shape of vesicle in large type of conidiophores.

Heterothallic. Cleistothecia superficial, scattered or aggregated in small clusters, at first white, then becoming pale yellow to light yellow (M.4A3-4 after Kornerup and Wanscher, 1978) or 'Primrose' to 'Pale luteous' (Rayner, 1970), globose to subglobose, 100-260 µm in diam, covered by hyaline to pale yellow hyphal strands; peridium thin, membranaceous, pseudoparenchymatous, composed of several layers of flattened cells; outer layer composed of hyaline, thick-walled, elongate, irregular cells measuring 3.5-10 µm wide, forming a 'textura epidermoidea'; inner layer of hyaline, thin-walled, angular cells, forming a 'textura angularis'. Asci 8-spored, irregularly disposed, borne in short, often twisted chains, arising as branches from ascogenous hyphae, globose to subglobose, 12-15.5 x 10-12 µm, evanescent at maturity. Ascospores maturing rapidly (8 days at 37°C), hyaline, one-celled, lenticular with smooth convex walls and two equatorial crests, 5-7 x 3-4.5 µm including crests, spore body 3.5-4 µm long; crests up to 1-1.5(-2.5) µm wide, angular in face view.

Mycelium composed of hyaline to pale yellow, branched, septate, roughened by pigmented granules, 1.5-3.5 µm wide hyphae. Cleistothecial initials beginning as upright branches of hyphae with loose curled tips (ascogonium), becoming surrounded by thin hyphae arising from the opposite mating strain. Conidial heads hemispherical when young, then loosely columnar, 120-300 x 40-80 µm. Conidiophores usually arising from the basal felt, sometimes from aerial hyphae, of two kinds: (a) large type, more or less scattered, 500-1500 x 11-18(-25) µm, projecting above the layer of smaller conidiophores, distinctly roughened by numerous warts, thick-walled, hyaline to pale yellow-brown, gradually broadening to dome- or flask-shaped vesicles measuring (22-)25-52 µm in diam; (b) small type, 60-250 x 4-10 µm, smooth, thick-walled, hyaline, broadening to small vesicles measuring 8-15(-24) µm in diam. Metulae lacking. Phialides borne on the upper 1/2 to 3/4 surface of vesicle,



Figures 2-6. *Neosartorya spathulata*.
2. Paired culture of 'a' x 'A' on malt extract agar at 23° C, 10 days. x 1/2. 3. Asci. x 480. 4. Ascospores (SEM photograph). x 4600. 5. Conidial structures. x 200. 6. Conidia. x 1000.

crowded, flask-shaped, 6-10 x 2-4 µm. Conidia faintly yellow-green, mostly ellipsoidal, sometimes subglobose to ovoid, 3-5.5 x 2-4.5 µm, smooth.

Colonies on Czapek agar growing somewhat restrictedly, attaining a diameter of 33-38 mm within 7 days at 23°C, vegetative mycelium thin, almost submerged, bearing scattered grayish green (M.25B-C4, after Kornerup and Wanscher, 1978) or 'Greyish blue green' (Rayner, 1970) conidial heads; cleistothecia not appearing within 7 days; reverse uncolored. Colonies on malt extract agar spreading rapidly, attaining a diameter of 80 mm within 7 days at 23°C, floccose, composed of a thin basal felt in which numerous white to pale yellow cleistothecia develop only after appropriate pairings, producing abundant dull green to grayish green (M. 25D4-25C5 after Kornerup and Wanscher) or 'Glaucous blue-green' to 'Pistachio green' (Rayner) conidial heads, with an irregular lobate margin; reverse uncolored to somewhat grayish brown (M.8D3 after Kornerup and Wanscher) or 'Fawn' (Rayner) at center. Colonies on oatmeal agar growing moderately, attaining a diameter of 40-46 mm within 7 days at 23°C, floccose, grayish green, conidial heads and cleistothecia as described on malt; reverse uncolored. Colonies on both malt extract and oatmeal agars at 37°C growing more rapidly than at 23°C, thin, producing abundant conidia and cleistothecia after pairings.

Thermotolerant: The optimal temperature for growth and conidiogenesis is 28-43.5°C, reduced growth occurs within the range of 22.5-25.5°C, and the upper limit is near 47°C. No growth was observed at temperatures either below 20°C or above 50°C. In the response to temperatures, no difference was observed between the two mating strains.

Isolation: cultivated soil of *Alocasia macrorrhiza* fields in Tai-Ping Village, Ilan Prefecture, Formosa, 13. x.1982, coll. M. Takada.

Holotype: The type of *N. spathulata* is a dried culture of NHL 2948 x 2949 preserved in NHL 2947. Subcultures of the 'A' (NHL 2948) and 'a' (NHL 2949) mating types are deposited in the American Type Culture Collection.

Neosartorya spathulata is clearly distinguished from *N. fennelliae* by its yellow cleistothecia, catenated asci, and ascospores with nearly smooth convex surfaces in contrast with reticulate surfaces of ascospores of the latter species. Additionally, the conidial structures of *N. spathulata* are of two kinds and the conidia are large ellipsoidal, whereas *N. fennelliae* has one type of conidial structure and small globose-subglobose or ellipsoidal conidia.

Results of mating tests: All mating tests were carried out on malt extract and oatmeal agars at 25°C, 14 days or at 37°C, 8-14 days. The two tester lines of mating type 'A' and 'a' were established in the monoconidial strains from the Formosan isolates of this fungus. Matings between the two 'A' and 'a' tester lines, all of which were inoculated onto the agar plates, resulted in the appearance of two bands of fertile cleistothecia near the junction of the two colonies between the compatible strains (Fig. 2, Table 1). None of the crosses between *N. spathulata* and each strain of *N. fennelliae* (NRRL 5534 'A', 5535 'a'; NHL 2951 'A', 2952 'a'), however, was fertile (Table 1).

Table 1. Results of crosses between *N. spathulata* and two *N. fennelliae*

	N.spathulata NHL 2948(A)	*N.spathulata* NHL 2949(a)	*N.fennelliae* NRRL 5534(A)	*N.fennelliae* NRRL 5535(a)	*N.fennelliae* NHL 2951(A)	*N.fennelliae* NHL 2952(a)
N.spathulata						
NHL 2948(A)	-	+	-	-	-	-
NHL 2949(a)		-	-	-	-	-
N.fennelliae						
NRRL 5534(A)			-	+	-	+
NRRL 5535(a)				-	+	-
NHL 2951(A)					-	+
NHL 2952(a)						-

+: Fertile cleistothecia produced.
-: Fertile cleistothecia not produced.

Interspecific pairings between *N. spathulata* and *N. fischeri*: Kwon-Chung and Kim (1974) tested interspecific pairings between strains of *N. fennelliae* and other members of *Neosartorya* and reported that the strains of *N. fennelliae* stimulate hyphal growth of *N. fischeri* var. *glabra* along the line of contact. As summarized in Table 2, similar reaction was observed on the interspecific pairings between mating type strains of *N. spathulata* and *N. fischeri*. Stimulation of cleistothecial formation in *N. fischeri* var. *glabra* and var. *verrucosa* occurred along the line of contact when paired with *N. spathulata*.

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Table 2. Results of interspecific pairings of *N. spathulata* and other *Neosartorya* spp. on oatmeal agar at 26°C

Pairings of strains	Reactions	
	Clear zone formation	Cleistothecial band produced*
NHL2948(A)xM3061 *N.fischeri* var.*fischeri*	+	-
XM4690 *N.fischeri* var.*fischeri*	-	-
xM2522 *N.fischeri* var. *glabra*	+	-
xM3159 *N.fischeri* var. *glabra*	+	+
xM4693 *N.fischeri* var. *glabra*	+	+
xM4691 *N.fischeri* var.*verrucosa*	-	+
xM2311 *N.fischeri* var. *spinosa*	-	-
xM4165 *N.fischeri* var. *spinosa*	+	-
NHL2949(a)xM3061 *N.fischeri* var.*fischeri*	±	+
xM4690 *N.fischeri* var.*fischeri*	-	-
xM2522 *N.fischeri* var. *glabra*	+	±
xM3159 *N.fischeri* var. *glabra*	+	+
xM4693 *N.fischeri* var. *glabra*	+	+
xM4691 *N.fischeri* var.*verrucosa*	±	+
xM2311 *N.fischeri* var. *spinosa*	-	-
xM4165 *N.fischeri* var. *spinosa*	+	-

* Stimulation of cleistothecial production in *Neosartorya fischeri* strains, which was shown by dense band of cleistothecia, occurred along the line of contact.

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INTERSTERILITY GROUPS IN *PAXILLUS INVOLUTUS*

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Abstract

Compatibility tests with monokaryons from 25 basidiocarps of *Paxillus involutus*, collected in the surroundings of Uppsala, Sweden, showed the existence within this species of three intersterility groups, Nos. I, II and III, comprising 13, 7 and 5 basidiocarps, respectively. Group I showed a preference for conifers, groups II and III for deciduous trees, notably birch, as ectomycorrhiza symbionts. No distinct morphological characters distinguished the basidiocarps of the different intersterility groups. *P. involutus* and *P. filamentosus* were incompatible. Both species possessed a bifactorial mating system.

INTRODUCTION

The existence of intersterility groups has been demonstrated in many morphological (taxonomic) species of Hymenomycetes (Burnett 1965, Boidin 1977). The majority of these cases have been found among the wood and litter decomposing Aphyllophorales (Boidin 1977) and in coprophilic agarics (Lange 1952).

The large ecological group among the agarics and boleti, which forms ectomycorrhiza with forest trees, is less known in this respect. So far the only truly ectomycorrhizal species which has been shown to contain intersterility groups is *Laccaria laccata* (Fries 1983, Fries and

Mueller 1984). Since it may add to our understanding of the ecology, taxonomy and speciation of these highly developed hymenomycetes, their possible possession of intersterility groups ought to be further investigated. The present preliminary paper deals with this question in the species *Paxillus involutus*. A few isolates of the closely related species *P. filamentosus* were included for pairing experiments with *P. involutus*.

MATERIAL AND METHODS

Basidiospores of *Paxillus involutus* (Batsch: Fr.) Fr. were collected during the three years 1981, 1982 and 1983 from 25 basidiocarps found in different habitats in the surroundings of Uppsala, Sweden (Table 1). The basidiospores of *P. filamentosus* Fr. derived from 3 basidiocarps found at separate localities within the Uppsala region, all of them under alder on the shore of lakes. The spores were stored in sterile, plastic petri dishes at 4°C in darkness. They were germinated on nutrient agar plates with the aid of *Rhodotorula glutinis* (Fres.) Harrison colonies or *P. involutus* mycelium as inductors in the way described earlier (Fries 1978).

From the germinated spores of each collection (stock) about five, sometimes more than ten, monokaryons (monosporous mycelia) were isolated. The monokaryons were maintained on a Hagem (1910) malt extract agar medium (modified by Modess (1941) and diluted to 10%) with the following composition: Glucose 500 mg, KH_2PO_4 50 mg, $MgSO_4 \cdot 7\ H_2O$ 50 mg, NH_4Cl 50 mg, $FeCl_3$ 0.5 mg, malt extract 500 mg, agar 15 g, and distilled water 1 liter. This medium was also used for the plates on which the monokaryons were combined in the pairing tests. The result of a pairing was scored as positive, i.e., as having led to mating, if clamp connections were observed. As for other details in the culture technique, reference can be made to Fries (1983).

RESULTS

The performance of the pairing program in both *Paxillus* species met with some unexpected difficulties. Many of the monokaryons lost their mating capacity soon after isolation. This change was usually combined with a decline in growth rate and with morphological alterations leading to thinner, more uniform and fewer aerial hyphae. These degenerative changes often appeared as sectors of

Table 1. Short descriptions of the habitats from which the basidiocarps and corresponding spore collections (stocks) of *Paxillus involutus* originated. Pine (Scots pine) = *Pinus sylvestris* L. , spruce (Norway spruce) = *Picea abies* (L.) Karst., birch = *Betula pubescens* Ehrh. and *B. verrucosa* Ehrh., alder = *Alnus glutinosa* L., oak = *Quercus robur* L., and hornbeam = *Carpinus betulus* L.

Stock no.	Habitat
Group I:	
176	Forest (coniferous and deciduous); on an oak stump
357	Forest (coniferous and deciduous)
372	Forest (spruce only)
373	Garden (under birches and other deciduous trees)
380	Forest (pine only)
386	Park (under hornbeam only)
400	Forest (spruce only)
405	Forest (spruce only)
448	Forest (spruce only)
457	Forest (pine only)
577	Forest (pine and spruce); on a conifer stump
0501	Forest (pine only)
0502	Forest (pine only); on a conifer stump
Group II:	
148	Park lawn (birch only)
149	Park lawn (birch only)
339	Garden lawn (birch and other deciduous trees)
346	Garden flower bed with *Paeonia* (near birches)
459	Garden lawn (birch and spruce only)
547	Park lawn (birch and spruce only)
565	Garden lawn (birch and spruce only)
Group III:	
359	Park lawn (birch only)
455	Garden lawn (birch only)
531	Park lawn (birch only)
550	Garden lawn (birch only)
566	Park lawn (birch only)

Table 2. The result of pairings between monokaryons from stocks derived from basidiocarps representing different intersterility groups. The number of stocks tested in each group is given in brackets and the numbers of pairings resulting in clamp formation are underlined.

		Group I (13)	Group II (7)	Group III (5)
Group I (13)	No. of pairings	92	80	48
	Clamps	77	0	0
	No clamps	15	80	48
Group II (7)	No. of pairings	-	86	50
	Clamps	-	43	0
	No clamps	-	43	50
Group III (5)	No. of pairings	-	-	22
	Clamps	-	-	10
	No clamps	-	-	12

the growing mycelium, suggesting that they emanated from spontaneous mutations. They were more common in certain stocks than in others. Consequently, many strains which had been characterized in one year as to their compatibility properties could not be used for mating tests in the following year despite intermittant transfers to fresh media. Fortunately, however, at least one monokaryon of each stock remained unchanged and allowed the inclusion of new stocks into a general pattern, which in *P. involutus* was based on 375 intra- and interstock pairings.

These pairings showed that the stocks of *P. involutus* tested represented three intersterility groups, I, II and III, comprising 13, 7 and 5 stocks, respectively (Table 2). None of the 42 pairings made between monokaryons of *P. involutus* and *P. filamentosus* (not included in Table 2) resulted in a mating reaction.

By using young monokaryons for instrastock pairings it was demonstrated that both *P. involutus* and *P. filamentosus* possessed a bifactorial mating system (tetrapolar sexuality).

DISCUSSION

Although this investigation of the compatibility relations in the species *P. involutus* was based on spore collections from only 25 basidiocarps, picked at random within a relatively limited area, three intersterility groups, I, II and III, were recognized. This group intersterility was absolute, as seen from the 178, all negative, inter-group pairings (Table 2).

The fact that many intra-group pairings also gave negative results may indicate that several stocks within the same compatibility group contained the same mating type alleles, particularly in groups II and III. However, these negative pairings can also, at least partially, be a consequence of the reduction in mating capacity which often affects the monokaryotic tester strains in this species and may be due to degenerative mutations or early senescence.

None of the 42 pairings made between monokaryons from different stocks of *P. involutus* and *P. filamentosus* led to clamp formation. This confirms that these two, morphologically rather similar taxa, are indeed two separate species (cfr. Tuomikoski 1950).

As can be seen from Table 1, the 13 basidiocarps of group I had been collected with two exceptions (nos. 373 and 386) in coniferous or mixed forests. All 12 basidiocarps of groups II and III came from parks and garden lawns, always under birches, which sometimes were mixed with other trees. This could indicate a genetically controlled ecological difference between group I, "the forest type", on the one hand, and the groups II and III, "the park type", on the other. This difference might imply a preference for conifers as host trees in the forest type and a preference for birch as the host tree in the park type.

Even so, if these intersterility groups in *P. involutus* should be considered as real, taxonomic species, the basidiocarps ought to be distinguishable by reliable morphological characters. In fact, the appearance of the basidiocarp usually differed between the forest and the park types. In the forest type (group I) the basidiocarps most often occurred separately from each other in their habitats. The stipe was relatively thin and the edge of the mature basidiocarp was not, or only slightly, involute. In the park type (groups II and III) the basidiocarps usually grew closely together in tight groups with short, thick, connate stipes and with fleshy, often undulate-lobed caps. Even in the mature basidiocarp the edge remained thick and involute. However, within all groups some basidiocarps displaying an intermediate appearance occurred. Hence, no quantifiable or sufficiently identifiable micro- or macromorphological basidiocarp attributes were found that characterized all basidiocarps in the same group, nor was it possible in this way to distinguish unmistakably group I from groups II and III. It must of course be taken into account that morphological differences, when they occur, might be modifications caused by environmental differences between the habitats.

In three cases, nos. 176, 577 and 0502, all belonging to group I, basidiocarps were formed on deteriorating tree stumps. Laiho (1970) found that "*P. involutus* does not form sporophores when growing by a saprophytic mode of nutrition". Hence, it must be concluded that even in these cases part of the mycelium lived in symbiosis with roots of a living tree, whereas basidiocarp formation was favoured by another part of the same mycelium in decomposing wood.

The findings reported give the impression of a speciation process in progress, where three populations have already become genetically separated, one of them (No. I) preferring conifers, the two other (Nos. II and III) deciduous trees, especially birch, as mycorrhizal symbionts.

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HOST RANGE AND TAXONOMY OF OLPIDIOPSIS VARIANS

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SUMMARY

The host range of the endoparasite *Olpidiopsis varians* was tested with 50 species of the Saprolegniaceae and 11 species of the Pythiaceae. Variation in parasite thallus morphology on different susceptible hosts was determined. *Olpidiopsis varians* has thallus morphology and host range similar to *O. achlyae*. The validity of taxonomic characters is discussed, and the two species are synonymous; *O. varians* has priority.

INTRODUCTION

Olpidiopsis varians Shanor (Olpidiopsidaceae, Lagenidiales) is a monocentric, holocarpic endoparasite of saprolegniaceous fungi. This and other species of *Olpidiopsis* Cornu produce zoosporangia and resting bodies within their hosts.

In the genus *Olpidiopsis*, the host range and characteristics of the resting bodies are used as the basis for distinguishing species (Shanor, 1939a, b; McLarty, 1941a, b; Sparrow, 1960; Karling, 1981). The present investigation describes the host range and variation of *O. varians* grown in bacteria-free two-member cultures. The validity of the current taxonomic treatment of *O. varians* and closely related species is examined.

MATERIALS AND METHODS

The water mold hosts utilized in this study were collected from lakes in Athens County, Ohio, or contributed by Dr. Roland Seymour of The Ohio State University. Species to be tested as potential hosts were placed on sterile, low nutrient agar (AIM, Miller, 1967) and incubated for 24 h at 17 C. Sterile sesame seeds were placed along the leading edge of the mycelium, incubated for 24 h, and removed to sterile Petri dishes containing sterile, glass distilled water. Ten colonies of each potential host species were put into water culture with parasitized hyphae of the host, *Aplanopsis terrestris* Hohnk, containing actively discharging zoosporangia of the parasite. The hyphae were removed from the dish two hours later, and the test cultures were incubated at 17 C under intermittent light. Host species, infected by *O. varians*, were placed on low nutrient agar for 24 h, then sesame seeds were placed along the leading edge of the host mycelium and incubated for an additional 24 h. The host fungus on sesame seed was removed to water culture and reidentified to insure the correct identity of the host. Species that were not infected by the first inoculation were reinoculated with infected portions of host and incubated at 17 C for 24 h after which the original host was removed. The remaining test host culture was incubated for 5 days and re-evaluated for infection.

After hosts had been established, the following characters were recorded from 50 infected host hyphal tip regions, for a total representation of 200 parasite thalli: zoosporangial shape, length, and diameter; resting body diameter, pattern of resting body ornamentation, and extent of infection. The extent of infection was rated arbitrarily by the number of parasite thalli present in a mycelium of the host as follows: light infection = < 20 parasite thalli/host mycelium, moderate infection = > 20 < 50 parasite thalli/host mycelium, and heavy infection = > 50 parasite thalli/host mycelium.

In the Saprolegniaceae, 24 species of *Achlya* (*A. americana* Humphrey, *A. apiculata* de Bary, *A. cambrica* (Trow) Johnson, *A. caroliniana* Coker, *A. colorata* Pringsheim, *A. conspicua* Coker, *A. crenulata* Zeigler, *A. debaryana* Humphrey, *A. diffusa* Harvey ex Johnson, *A. dubia* Coker, *A. flagellata* Coker, *A. hypogyna*, *A. inflata* Coker, *A. lobata* Zeigler and Gilpin, *A. orion* Coker and Couch, *A. ornata*, *A. polyandra* de Bary, *A. primoachlya*, *A. prolifera* C. G. Nees, *A. proliferiodes* Coker, *A. oblongata* de Bary, *A. racemosa* Hildebrand, *A. recurva* Cornu, and *A. subterranea* Coker and Braxton), eight species of *Saprolegnia* (*S. asterophora* de Bary, *S. blelmempsis*, *S. diclina* Humphrey, *S. glomerata* (Tiesenhausen) Lund, *S. itoana*, *S. ferax* (Gruith.) Thuret, *S. subterranea* Dissmann, *S. terrestris* Cookson, *S. truncata*), four species of *Brevilegnia* (*B. bispora* Couch, *B. globosa* Zeigler, *B. linearis* Coker and Couch, *B. irregularis* Rossy-Vladerrama), two species of *Aplanopsis* (*A. spinosa*, *A. terrestris*), three species of *Dictyuchus* (*D. monosporous* Leitgeb, *D. achlyoides*, *D. pseudodictyon*), and *Aphanomyces laevis* de Bary, *Geolegnia septisporangium*, *Leptolegnia ornata*, *Phragmosporangium terrestris*, *Plectospira gymnonifera*, *Protoachlya mucronata* Coker and *Pythiopsis cymosa* Coker were tested as potential host species. In the Pythiaceae, seven species of *Pythium* (*P. acanthicum* Dreshler, *P. aphanidermatum* (Edson) Fitzpatric *P. debaryanum* Hesse, *P. irregulare* Buisman, *P. proliferum* de Bary, *P. pulchrum* Minden, and *Pythium* sp.) and four species of *Phytophthora* (*P. cinnamoni* Rands, *P. citricola* Sawada, *P. infestans* (Montange) de Bary, and *P. palmivora* (Butler) Butler) were tested.

RESULTS

Olpidiopsis varians infected *Achlya colorata*, *A. dubia*, *A. americana*, *A. proliferoides*, *A. flagellata*, *A. racemosa*, *Aplanopsis spinosa*, *A. terrestris*, *Geolegnia spetisporangium*, *Protoachlya mucronata*, *Saprolegnia blelmempsis*, and *S. itoana*. None of the Pythiaceae tested was parasitized. *Achlya americana*, *A. dubia*, *A. flagellata*, *A. proliferoides*, *Aplanopsis terrestris*, *Protoachlya mucronata* and *Saprolegnia blelmempsis* were the most heavily parasitized by *O. varians* (Table 1). *Achlya colorata* and *Geolegnia septisporangium* were moderately infected, while *Achlya racemosa*, *Aplanopsis spinosa*, and *Saprolegnia itoana* were only lightly infected (Table 1).

Olpidiopsis varians produces spherical or ellipsoidal zoosporangia in all of the host taxa which were parasitized. Within the *Achlya* hosts and *Aplanopsis terrestris*, fusiform zoosporangia were also produced. The size of the zoosporangia varied among the susceptible hosts. The largest zoosporangia were produced within *Achlya* hosts, followed in decreasing size by *A. terrestris*, *S. blelmempsis*, *G. septisporangium*, and *P. mucronata* (Table 1).

The diameter of resting bodies produced by *O. varians* varied among susceptible hosts. *Olpidiopsis varians* grown on *Achlya* hosts produced the largest resting bodies, followed by *S. blelmempsis*, *Aplanopsis terrestris*, *G. septisporangium*, and *P. mucronata*. No resting bodies of the parasite were found in *S. itoana* and *Aplanopsis spinosa*. The resting body wall ornamentations produced by *O. varians* varied from broad tapering spines to a wavy undulate ornamentation. On *Achlya* hosts, the parasite resting bodies had both broad triangular spines and undulate wall ornamentations. On *Aplanopsis terrestris* and *P. mucronata*, the parasite produces only triangular spines and on *G. septisporangium* and *S. itoana* only undulate walls are formed (Table 1).

DISCUSSION

The host range exhibited by *O. varians* is wider than previously reported by Shanor (1940). His report describes this parasite infecting only species of *Achlya*. In the present investigation, representatives of five genera of the Saprolegniaceae were successfully infected (Fig. 1). The wide range of host infection may indicate a physiological relationship among these host species. Certainly, the factor which enabled *O. varians* to infect and develop within these hosts is present in all parasitized taxa. Biochemical investigations could follow to determine the relationships between these morphologically different hosts.

Olpidiopsis varians exhibits variable morphology when grown on different host taxa. Cornu (1872) separated *O. fusiformis* Cornu from other species of *Achlya*-inhabiting olpidiopsoid fungi on the basis of the fusiform shape of

Table I. Morphological variation exhibited by *Olpidiopsis varians* grown in different host fungi.

Host Species	Extent of Infection	Resting Bodies Diameter (µm)	Resting Bodies Wall Ornamentation
Achlya americana	+++[1]	18-83 (54 ± 17)[3]	U,T[4]
A. clorata	++	22-96 (63 ± 11)	U,T
A. dubia	+++	12-86 (44 ± 16)	U,T
A. flagellata	+++	42-134 (82 ± 24)	U,T
A. proliferoides	+++	28-103 (52 ± 19)	U,T
A. racemosa	+	15-86 (63 ± 14)	U,T
Aplanopsis spinosa	+	N	
A. terrestris	+++	27-59 (46 ± 9)	T
Geolegnia septisporangium	++	16-63 (41 ± 6)	T
Protoachlya mucronata	+++	19-72 (46 ± 12)	T
Saprolegnia blelmempsis	+++	29-68 (53 ± 10)	T
S. itoana	+	N	

Continued on page 5

Host Species	Extent of Infection	Zoosporangia		
		Shape	Length (µm)	Diameter (µm)
Achlya americana	+++[1]	S,F,E[2]	69-145 (110 ± 23)[3]	26-82 (55 ± 12)[3]
A. clorata	++	S,F,E	72-154 (119 ± 14)	27-93 (72 ± 21)
A. dubia	+++	S,F,E	43-171 (124 ± 29)	39-94 (52 ± 11)
A. flagellata	+++	S,F,E	94-320 (172 ± 56)	11-116 (91 ± 23)
A. proliferoides	+++	S,F,E	83-131 (81 ± 16)	26-99 (73 ± 7)
A. racemosa	+	S,F,E	42-112 (93 ± 19)	23-92 (93 ± 31)
Aplanopsis spinosa	+	S,E	16-96 (43 ± 13)	8-43 (35 ± 6)
A. terrestris	+++	S,F,E	10-154 (93 ± 22)	7-86 (63 ± 14)
Geolegnia septisporangium	++	S,E	13-84 (42 ± 13)	13-52 (35 ± 6)
Protoachlya mucronata	+++	S,E	10-54 (38 ± 9)	17-49 (38 ± 4)
Saprolegnia blelmempsis	+++	S,E	26-115 (72 ± 4)	16-84 (61 ± 5)
S. itoana	+	S,E	32-96 (54 ±10)	12-47 (42 ± 8)

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[1] +=light infection
++=moderate infection
+++=heavy infection

[2] S=spherical
F=fusiform
E=ellipsoidal

[3] range (mean ± standard deviation)

[4] U=undulate
T=tapering spines

N=not formed

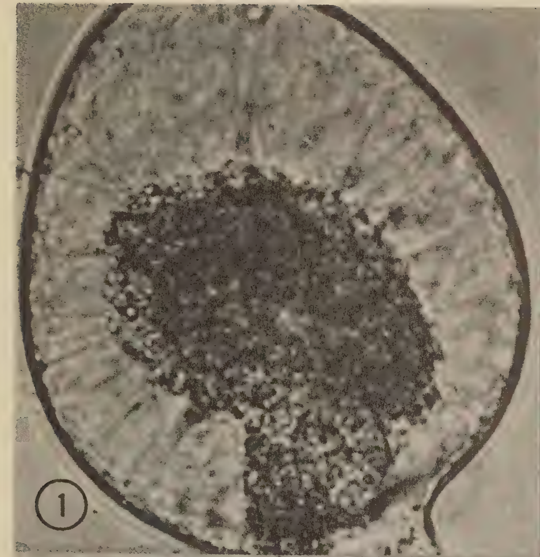
the zoosporangium. Although he and Khulbe and Bharagava (1981) report O. fusiformis as a parasite of A. flagellata, Shanor (1940) was unable to infect A. flagellata with O. varians even in repeated attempts. It is possible that Cornu (1872) and Khuble and Bharagava (1981) misidentified their host fungus or the lack of bacteria-free two-member culture conditions influenced their results.

The size of zoosporangia and resting bodies produced by O. varians when grown on different hosts is influenced by the size of the host. Host taxa having large hyphae (for example, Achlya spp.) contain a larger volume of cytoplasm for the parasite to develop than do host taxa having smaller hyphae (members of Saprolegnia, Aplanopsis, Geolegnia, Protoachlya). Therefore, zoosporangial size is much too variable for use as a taxonomic criterion.

The absence of resting bodies in Saprolegnia itoana and A. spinosa may be a characteristic of weakly infected hosts. These hosts were much more successful at blocking parasite infections and were only lightly infected. The absence of parasite resting bodies may indicate that an important metabolite needed by the parasite was lacking in these hosts and only parasite zoosporangia could develop without it. Biochemical studies of these weakly infected host taxa could aid in the identification of such unknown growth factors.

The morphological variation observed in O. varians when cultured in different hosts overlaps descriptive characters of other olpidiopsoid fungi. Olpidiopsis fusiformis, O. varians, O. achlyae McLarty, and O. verrucosa Johnson all produce spherical, ellipsoidal, or fusiform zoosporangia and may produce resting body wall ornamentations with undulate margins. However, host range studies by Shanor (1940) and Johnson (1955) indicate that O. fusiformis and O. verrucosa will not infect similar hosts. The results of the present study indicate that O. varians infects all of the species reported within the host range of O. achlyae by McLarty (1941). On the basis of the morphological characteristics shared by O. varians and O. achlyae and the similarity in host range, O. achlyae is hereby relegated to synonymy with O. varians which has priority. A comparison of host range and morphological variation for the remaining members of the

Figures 1-6. Olpidiopsis varians. Representative infected host taxa. Fig. 1. Bright field light micrograph of Aplanopsis spinosa infected by O. varians. X 880. Fig. 2. Phase contrast light micrograph of Geolegnia septisporangia infected by O. varians. X 660. Fig. 3. Differential interference light micrograph of Achlya flagellata infected by O. varians. X 660. Fig. 4. Phase contrast light micrograph of Saprolegnia blelmempsis infected by O. varians. X 660. Figs. 5, 6. Phase contrast light micrographs of Protoachlya mucronata infected by O. varians. X 660.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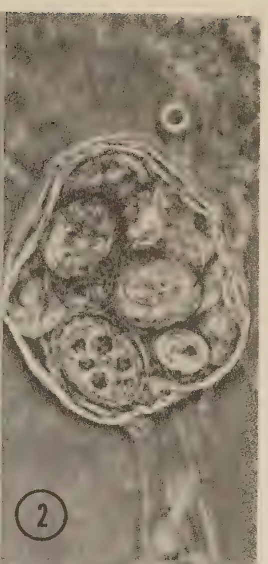
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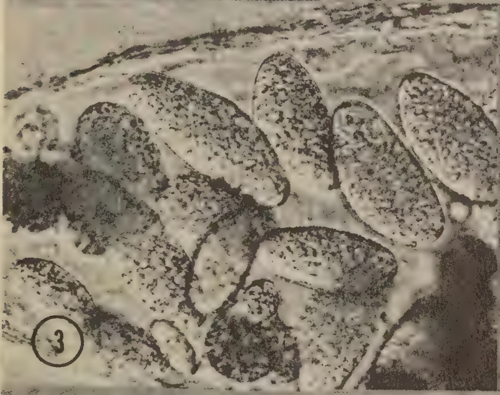
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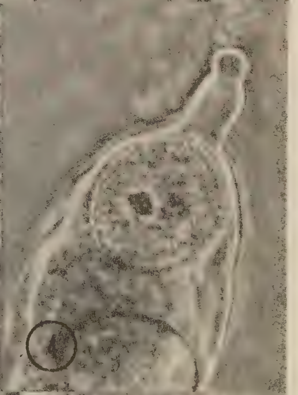
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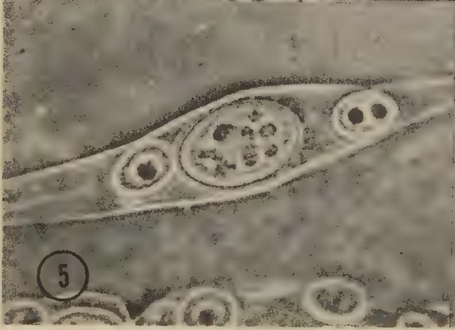
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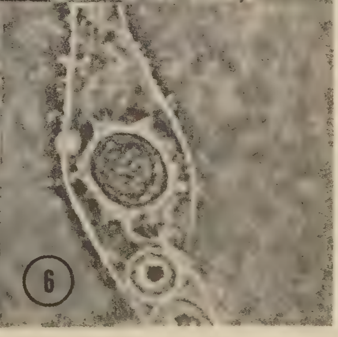
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Olpidiopsidaceae is necessary for further taxonomic treatment of the family.

ACKNOWLEDGMENTS

The senior author dedicates this work to Professor Charles E. Miller for his keen interest and support throughout the course of this study.

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MYCOTAXON

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TYPES AND TYPE COLLECTIONS OF NEW HIGHER MARINE AND FRESHWATER FUNGI FROM THE BALTIC COAST

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Among higher marine fungi collected in the late sixties and beginning seventies at the Baltic coast 10 new species, 4 Fungi Imperfecti and 6 Ascomycetes, were found. The descriptions were published by KOHLMEYER, SCHMIDT and NAIR (1967) and SCHMIDT (1969a, 1969b, 1974). In the case of 6 taxa, 2 genera and 4 species, publication corresponds to the directions of the International Code of Botanical Nomenclature (1983):

- Corollospora pulchella KOHLM., SCHMIDT et NAIR (1967)
- Corollospora intermedia SCHMIDT (1969b)
- Carbosphaerella SCHMIDT (1969a)
- Carbosphaerella pleosporoides SCHMIDT (1969a)
- Carbosphaerella leptosphaerioides SCHMIDT (1969b)
- Crinigera SCHMIDT (1969b)

The remaining taxa are not validly published according to ICBN because the designation of the type was omitted or, in one case, a preoccupied generic name was used. In the following, the missing informations and a new name are given. Types are deposited at Jena (JE).

Designation of types for:

- Cirrenalia fusca I. SCHMIDT spec. nov.
  Diagn. lat.: Feddes Repertorium 80: 110. 1969
  Typus: 20. IV. 1966, G.D.R., Baltic Sea, Darsser Boddenkette, Grabower Bodden. Holotypus: substrate and preparation No. 39, JE. Isotypus: private collection I. SCHMIDT
  Paratypus: V. 1966, G.D.R., Baltic Sea, island "Hiddensee", westcoast near Kloster; preparation No. 50, JE and private collection of I. SCHMIDT
- Trichocladium constrictum I. SCHMIDT spec. nov.
  Diagn. lat.: Natur Naturschutz Mecklenburg 12: 114. 1974
  Typus: 20. IV. 1966, G.D.R., Baltic Sea, Darsser Boddenkette, island "Barther Oie". Holotypus: substrate and preparation No. 41, JE

Paratypus: 27. IV. 1968, G.D.R., Baltic Sea, island "Rügen", Grosser Jasmunder Bodden near Lietzow; preparation No. 175, JE and private collection I. SCHMIDT

- *Trichocladium lignincola* I. SCHMIDT spec. nov.
  Diagn. lat.: Natur Naturschutz Mecklenburg 12: 116. 1974
  Typus: 13. V. 1968, G.D.R., river "Peene" near Anklam. Holotypus: preparation No. 238, JE
  Paratypus: 20. XI. 1967, G.D.R., river "Peene" near Gützkow, preparation No. 227, JE and private collection I. SCHMIDT
- *Halosphaeria viscosa* I. SCHMIDT spec. nov.
  Diagn. lat.: Natur Naturschutz Mecklenburg 12: 70. 1974
  Typus: 5. VI. 1967, G.D.R., Baltic Sea, island "Rügen" near Glowe. Holotypus: substrate and preparation No. 148, JE
  Paratypus: 5. VI. 1967, G.D.R., Baltic Sea, island "Rügen" near Glowe, preparation No. 147, JE and private collection I. SCHMIDT
- *Crinigera maritima* I. SCHMIDT spec. nov.
  Diagn. lat.: Natur Naturschutz Mecklenburg 7: 11. 1969
  Typus: 14. II. 1968, G.D.R., Baltic Sea, shore near Gross-Schwansee. Holotypus: preparation No. 211, JE
  Paratypus: 14. II. 1968, G.D.R., Baltic Sea, shore near Gross-Schwansee, preparation No. 214, JE and private collection I. SCHMIDT.

The last species is a new marine Fungus Imperfectus published under the name *Vesicularia marina* gen. nov. spec. nov. (SCHMIDT 1974). *Vesicularia* is a preoccupied name, and my generic name is thus a later homonym. It is necessary to propose a new name for it:

- *Cumulospora* I. SCHMIDT gen. nov.
  Diagn. lat.: Hyphis septatis et ramosis; conidiophoris obsoletis vel similis hyphis; conidiis griseis vel fuscis, multicellulatis, moriformibus; cellulis externis globosis vel vesicariis, majoribus quam cellulae internae; axis conidiorum saepe convoluti, sed numquam, sicut apud genera *Cirrenalia* et *Zalerion*, in via spirarum; etym.: lat. *cumulus* = heap, but also special form of a cloud, in reference to the form of the conidia.

= *Vesicularia* I. SCHMIDT, Natur Naturschutz Mecklenburg 12: 117. 1974, non *Vesicularia* MICH. ex TARGIONI-TOZETTI 1826, nec *Vesicularia* (K. MÜLL. hal.) K. MÜLL. hal. 1896, nec *Vesicularia* VOLOGDIN 1962.

Typus: *Cumulospora marina* I. SCHMIDT spec. nov. =
Vesicularia marina I. SCHMIDT, Natur Naturschutz Mecklenburg 12: 117-119. 1974

- *Cumulospora marina* I. SCHMIDT spec. nov.

Diagn. lat.: Natur Naturschutz Mecklenburg 12: 117-118. 1974
Typus: III. 1966, G.D.R., Baltic Sea, Strelasund near Stralsund; Holotypus: substrate and preparation No. 19, JE
Paratypus: 4. V. 1968, G.D.R., Baltic Sea, island "Hiddensee" near Kloster, preparation No. 169, JE and private collection of I. SCHMIDT.

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I am indebted to Dipl.-Biol. G. HIRSCH, Jena, and Prof. J. KOHLMEYER, U.S.A., for reviewing the manuscript and good advice with reference to the employment of the ICBN.

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MYCOTAXON

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REDISPOSITION OF RADULUM CONCENTRICUM (APHYLLOPHORALES, CORTICIACEAE)

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SUMMARY

Radulum concentricum, known from British Columbia, Washington, Oregon, California and Montana, is described and illustrated. The new combination *Phlebia concentrica* is proposed.

During the past several years, three specimens of *Radulum concentricum* Cooke et Ellis were collected from decayed deciduous wood in western Oregon. Cultures obtained from these specimens were similar to unidentified cultures isolated from decayed, air-seasoned Douglas-fir (*Pseudotsuga mensiesii* (Mirb.) Franco) utility poles. Monokaryotic isolates obtained from fructifications produced by fungal isolates from utility poles were compatible with those from the Oregon specimens and therefore conspecific. Our studies of the basidiocarps and cultures of *R. concentricum* and its potential role in wood products pathology, prompted us to re-evaluate its taxonomic position. We propose the transfer of *R. concentricum* to Phlebia. We also include a description and illustration of *Phlebia concentrica*.

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*Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

MATERIALS AND METHODS

The microscopic characteristics of the basidiocarps were examined by mounting sections in 5 percent KOH and 1 percent aqueous phloxine B. Additionally, a drop of 2 percent KOH was applied to basidiocarps and any color change noted. All color designations are taken from Ridgway (1912).

Cultural studies followed the methods described by Stalpers (1978) and Nobles (1948, 1965). Isolates were grown for 2 weeks on 2 percent malt extract agar (MEA), 0.5 percent gallic acid agar (GAA) and 0.5 percent tannic acid agar (TAA) in the dark at 25°C. The mycelia at the margin and center of the colonies were examined at 7 and 14 days. The production of extracellular phenoloxidases was determined by a pale purple reaction of the colonies with alpha-naphthol (Stalpers, 1978) and by a brown diffusion zone around colonies growing on GAA and TAA (Davidson *et al.*, 1938).

Dikaryotic cultures were obtained by tissue explants from basidiocarps and by streaking basidiospores onto MEA plates. Monokaryotic cultures were obtained by streaking a spore suspension onto MEA plates and isolating clampless colonies. To determine the mating system, 7 monokaryons were paired in all possible combinations. Compatible matings were scored by the presence of clamp connections. Sexual compatibility between different specimens was determined by pairing monokaryons from each.

RESULTS

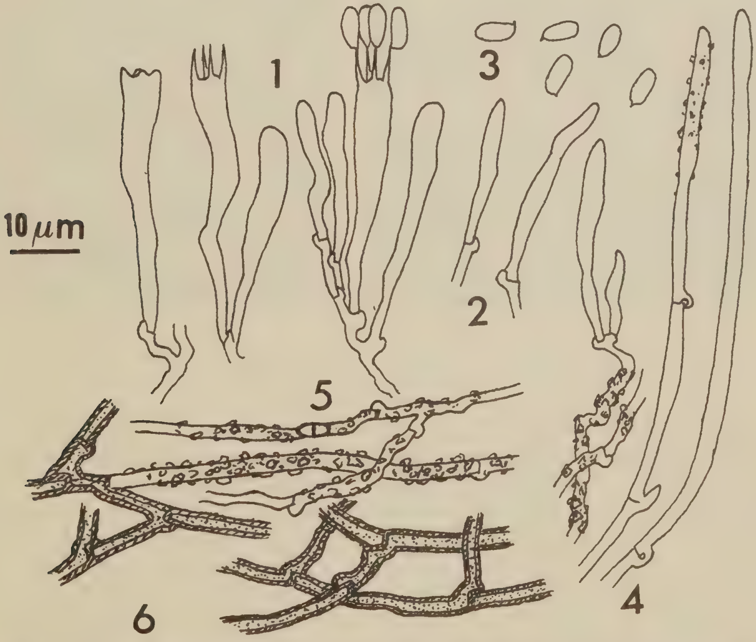
Phlebia concentrica (Cooke et Ellis) Kropp et Nakas., *comb. nov.*

Basionym: *Radulum concentricum* Cooke et Ellis, Grevillea 14:13. 1885.
= *Irpex owensii* C. G. Lloyd, Mycol. Writ. 5, Mycol. Notes p. 616. 1916.
≡ *Radulum owensii* (C. G. Lloyd) C. G. Lloyd, Mycol. Writ. 5, The genus *Radulum* p. 10. 1917.

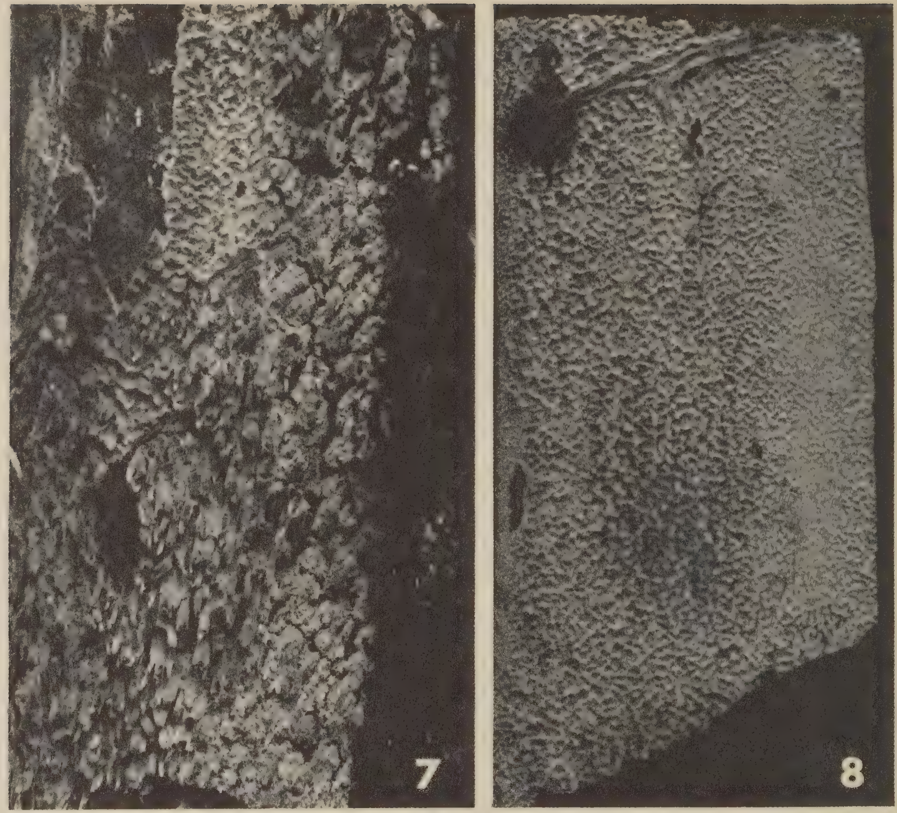
Basidiocarps annual, adnate, effuse up to 10 x 5 cm, up to 750 µm thick not including teeth; hymenophore odontoid, or merulioid (Figs. 7,8), Ochraceous-Orange with

Warm Buff to Antimony Yellow margins, fresh specimens, bright red then black in 2 percent KOH, dried herbarium specimens Onionskin Pink to Fawn Color, darkening to Verona Brown or Chestnut-Brown, margins concolorous or Buff-Pink, black in 2 percent KOH; teeth up to 3 mm long, terete, conical to flattened, single or confluent at base, soft, smooth, apices rounded, entire; margins distinct, abrupt, smooth, occasionally with a few, small teeth, sterile or fertile; subiculum and central trama of teeth dark brown.

Hyphal system monomitic. Subiculum up to 600 µm thick, composed of densely interwoven hyphae; subicular hyphae (Fig. 6) 3-4.5 µm diam, walls dark yellowish brown, slightly thick to thick-walled, nodose-septate, frequently branched, continuous with tooth trama; subhymenium up to 100 µm thick, dense, composed of vertically arranged hyphae;



Figs. 1-6. Microscopic characters of Phlebia concentrica (OSC # 41,587). (1) mature and developing basidia; (2) cystidioles; (3) basidiospores; (4) projecting hyphal ends; (5) subhymenial hyphae; (6) brown, thick-walled subicular hyphae.



Figs. 7-8. Basidiocarps of Phlebia concentrica (approx. 2X). (7) OSC # 41,588; (8) OSC # 41,589.

subhymenial hyphae (Fig. 5) 2.5-3.5 µm diam, hyaline, thin-walled, nodose-septate, moderately branched, encrusted with yellow, resinous material; hyphal ends projecting from tooth apex present in some specimens (Fig. 4) 2.5-4 µm diam, hyaline, thin-walled, nodose-septate at base, lightly encrusted; cystidioles (Fig. 2) hyphoid, 20-33.5 x 2.5-3.5 um, hyaline, thin-walled, nodose-septate at base, embedded, abundant to rare; basidia (Fig. 1) narrowly clavate, 27-45(-50) x 5-6 µm, hyaline, thin-walled, nodose-septate at base, 4-sterigmate, coated with yellow, resinous material; basidiospores (Fig. 3) ellipsoid to subcylindrical, (5-)6-7.5(-10) x 2.5-3.5 µm, hyaline, thin-walled, smooth, non-amyloid.

Specimens examined: OREGON-Benton County: OSC # 41,588, coll. G. Nielson, MacDonald State Forest, Oak Creek Drainage; OSC # 41,589, coll. B. Kropp, MacDonald State Forest, Soap Creek Drainage; OSC # 41,587, coll. B. Kropp, Woods Creek Road. Curray County: J. L. Lowe 10540, Gold Beach; FP 133211 and FP 133258, coll. M. J. Larsen, Siskiyou Nat. Forest, Winchuk Campground; FP 133272, coll. M. J. Larsen, Siskiyou Nat. Forest, Wheeler Creek.

Cultural description: Growth rapid, >70 mm radius in 7 da on MEA; colonies white, thin to moderately thin, appressed, subfelty to arachnoid; margins even to slightly bayed, appressed; no reverse discoloration or partially bleached at 14 da, bleached and/or Buckthorn Brown at 6 wk; oxidase reactions negative with alpha-napthol at 7 da, but weakly positive at 14 da; on TAA negative or stain, growth 0-17 mm diam at 7 da, 0-26 mm diam at 14 da; on GAA negative, growth variable, 8-12 mm or 68-90 mm diam at 7 da, 20-36 mm or 90 mm diam at 14 da, colony appressed, hyaline, with a dense submerged mat and irregular margins.

Hyphae of advancing zone 2.5-6(-7.5) µm diam, thin-walled, simple-septate, sparingly branched, clamps forming 20-25 mm behind the margin. Submerged, surface and aerial hyphae 1.5-6 µm diam, thin-walled, nodose-septate, frequently branched, surface and aerial hyphae coated with a thin, sparse layer or crystalline or resinous material that dissolves in 2 percent KOH. Chlamydospores globose, 10-25(-58) µm diam, hyaline, slightly thick-walled, thallic, intercalary, or terminal, numerous in surface mat, but rare in submerged mat at 2 and 6 wk. Cultures studied: OSC # 41587, OSC # 41588, and OSC # 41589. Incompatibility system: Seven single-spored isolates from OSC # 41587 were paired in all combinations. Two mating types were identified: A_1 = 1,2,3,4,7 A_2 = 5,6. Thus, _P_. _concentrica_ is heterothallic and bipolar.

DISCUSSION

Phlebia _concentrica_ is known from British Columbia, Washington, Oregon, California and Montana. It causes a white-rot decay of conifer and hardwood slash. Recently, monokaryotic cultures were isolated from non-treated, air-seasoned Douglas-fir utility poles. This suggests that basidiospores of *P. concentrica* become airborne and colonize exposed wood surfaces.

For a description of the type specimens of *Irpex owensii* and *Radulum concentricum* see Gilbertson (1963 and 1964, respectively). Perhaps the most striking feature of this species is the dark brown hyphae found in the subiculum and tooth trama. The texture of *P. concentrica* is soft unlike most other *Phlebia* species which are ceraceous to corneous.

Phlebia concentrica is most similar to *Phlebia centrifuga* Karst. Both species produce brown subicular hyphae. In *P. concentrica* the subiculum and tooth trama consists of brown subicular hyphae while in *P. centrifuga* only a few subicular hyphae next to the substrate are brown. Both species have narrowly clavate basidia, ellipsoid to subcylindrical basidiospores, and encrustations on the subhymenial hyphae. Whereas the hymenophore of *P. centrifuga* is papillose to wrinkled and the subicular hyphae are arranged parallel to the substrate, *P. concentrica* has well developed teeth and the subicular hyphae form a dense, interwoven tissue.

Cultures of *Phlebia concentrica* are most similar to those of *P. subserialis* (Bourd. et Galz.) Donk (Nakasone *et*. *al*., 1982). Both species grow rapidly on MEA, are weakly positive on GAA, grow faster on GAA than TAA, lack clamps in the marginal hyphae, and develop chlamydospores. The differences in culture are subtle. The aerial and surface hyphae of *P. concentrica* are thinly coated with resinous or crystalline material that dissolves in 2 percent KOH; *P. subserialis* lacks this character. *Phlebia subserialis* develops thick-walled hyphae which are absent in *P. concentrica*.

Phlebia concentrica has characters typical of both *Phlebia* and *Mycoacia*. These genera are similar parcicularly with regard to microscopic characters. *Mycoacia* species typically are hydnaceous, pale yellow in young specimens, and turn red in 2% KOH. But some species of *Phlebia* are ochraceous to yellow, and at least two (*Phlebia centrifuga* and *P. chrysocrea* (Berk. et Curtis in Berk.) Burds. in Lombard, Burds. et Gilbn.) turn red in KOH. The hymenophore of *Phlebia* species ranges from smooth to odontoid or meruloid. *Phlebia queletii* (Bourd. et Galz.) M. P. Chris., for example, is odontoid and ranges in color from white to yellow ochraceous. Eriksson *et al.* (1981) in fact have suggested that *P. queletii* could easily be placed in *Mycoacia*.

Because *Phlebia concentrica* is odontoid, yellowish in color when fresh, and turns red in 2 percent KOH, it could be placed in *Mycoacia*. However, since the hymenophore of *P. concentrica* occasionally is merulioid, it seems better placed in *Phlebia*. Additionally, cultures of *P. concentrica* are similar to those of true *Phlebia* species (Nakasone *et al.* 1982).

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ON THE HYPOCHNICIUM EICHLERI COMPLEX (BASIDIOMYCETES)

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ABSTRACT. *Hypochnicium eichleri* and *H. punctulatum* have been regarded as two closely related species, morphologically separated by different spore sizes. By the use of incompatibility tests and culture studies it is here shown that the applied concept of *H. eichleri* comprises at least two species, represented by authentic specimens of *Peniophora eichleri* Bres. and *Hypochnus albostramineus* Bres. The new combination *Hypochnicium albostramineum* is proposed and most specimens from North Europe which hitherto have been treated under *H. eichleri* are referred to that species.

INTRODUCTION. Within the *Hypochnicium eichleri* complex several species have been described (see Eriksson and Ryvarden, 1976; Rogers and Jackson, 1943). Rogers and Jackson synonymized them all under *Corticium punctulatum* Cooke, which is the oldest published name for a member of this complex. Eriksson and Ryvarden segregated *H. eichleri* from *H. punctulatum* because it had bigger spores, different ecology and different geographical distribution among the Nordic specimens. Hallenberg (1983) reported *H. punctulatum* to be heterothallic and tetrapolar while homothallism was indicated for *H. eichleri*. However, among herbarium collections there are several specimens where the spore size is intermediate and which - as far as known - not are easily distinguished on ecological criteria or differences in distributional pattern from the two species mentioned above. It is here shown that such specimens are incompatible with *H. punctulatum* and *H. eichleri* sensu Eriksson and Ryvarden (1976). There are also differences in culture characters between the three species.

METHODS. Compatibility tests have been done by mating single-spore (SS) cultures from different specimens. When compatible mating types have been available in a specimen, these have been used in intercompatibility matings. Common malt agar (1,25 % malt extract) has been used as medium. Culture character of PS-mycelium was analyzed after 3 and 6 weeks growth. Culture codes are from Nobles (1965) with emendations by Boidin and Lanquetin (1983); drop tests for extracellular oxidases follow Marr's directions (1979).

RESULTS. For detailed morphological descriptions of *H. punctulatum* and *H. eichleri*, see Eriksson and Ryvarden (1976). Data on specimens studied are categorized by slanted lines: Culture number/ substrate/ locality/ number of available SS-cultures or SS-numbers of cultures belonging to compatible mating types.

Material:
GB 160 / Abies/ Denmark, Lolland/ 1/2; 3/4.
GB 29/ decid. wood/ Sweden, Västergötland/ 2 SS, clamped.
GB 269/ Betula/ Sweden, Torne Lappmark/ 5 SS, clamped.
GB 936/ Picea/ Scotland, Perthshire/ 7 SS.
GB 938/ Betula/ Scotland, Perthshire/ 6 SS.
GB 1065/ Betula/ Romania, Suceava/ 10 SS.
GB 1203/ Alnus/ Norway, Hordaland/ 5 SS.
GB 1362/ Fagus/ Sweden, Dalsland/ 2/1,3.

Three taxonomical entities, incompatible with each other, are recognized:

Group I. Incompatibility between GB 160 and the other cultures. This specimen has small spores and belong to *H. punctulatum* in the sense of Eriksson and Ryvarden (1976). As reported earlier (Hallenberg, 1983) it is heterothallic and tetrapolar.

Group II. This group consistes of GB 936, GB 938, GB 1065, GB 1203, and GB 1362. These were compatible with each other, however partial compatibility was noted according to the following:

	GB 936-1	GB 936-3	GB 1065-1	GB 1065-2
GB 938-1	-	-	-	-
GB 938-3	+	+	-	-
GB 1362-1	+	+	-	-
GB 1362-2	+	+	+	+

There are several possible explanations for the negative results above and this problem is not further discussed here. These specimens are regarded as conspecific. They are incompatible with GB 160, and in di-mon matings with GB 29 and GB 269 (no clamps were formed on the haploid side). The specimens of this group conform with an authentic specimen of *H. eichleri*.

Group III. GB 29 and GB 269 have been regarded as homothallic, because isolated SS-mycelia were clamped (Hallenberg, 1983). Further indications for homothallism were obtained by the use of neohaploidisation. Clamped mycelia were cultured on agar plates with a different concentration of oxgall. The plates with a concentration where no clamps were visible have then been homogenized in a "Ultra Turrax" homogenizator. After dispersal and growth for a couple of days, clampless germlings were isolated. When checked 15 days later, all isolated mycelia were clamped (GB 29). In GB 269 all germlings were clamped already when isolated. These specimens have the biggest spores among the tested ones and are conspecific with authentic material of *H. albostramineus*.

As mentioned above, the only morphological differences between these species seem to be in spore size. Spores have been measured in authentic specimens of P. eichleri, H. albostramineus, and from spore prints of the tested specimens.

According to Corticiaceae of North Europe (1978):
H. punctulatum: (5-)5,5-6,6-(7,5) x 4,5-5 µm
H. eichleri: 8-10-(12) x 6-7-(9) µm

Spore sizes in authentic specimens:
Peniophora eichleri Bres.(auf Alnus Rinde/ Polen, Gouv. Siedlve, pr. Miedzyrzyve/ Mai, leg. B. Eichler/ S):
7-8 x 5,5-6,5 µm
Hypochnus albostramineus Bres. in Sacc. and Syd. (ad ramos Populi tremulae/ Martio/ 1901, Eichler/ S):
8-10,5 x 6-8 µm

Spore sizes in the different specimens tested. The different incompatibility groups marked I - III:

I. GB 160: 5,5-6,5 x 5-5,5 µm

II. GB 936: 7-7,5 x 5,5-6,5 µm
GB 938: 7-8 x 6,5-7 µm
GB 1065: 6,5-8 x 6-7 µm
GB 1203: 7-8,5 x 6-6,5 µm
GB 1362: 7,5-8,5 x 6-7 µm

III. GB 29: 8-9 x 6,5-7 µm
GB 269: 8-9 x 6,5-7 µm

CULTURE CHARACTERS. These are given for GB 160 and GB 269 in Hallenberg (1983). Characters for H. eichleri, GB 1065 (group II) is given below:
Aerial mycelium downy. Advancing zone even, appressed. Hyphae with clamps at all septa, ordinarily branched, 2-6 µm wide, walls thin to slightly thickened, partly irregularly widened; gloeocystidium-like structures present. Chlamydospores present, subglobose, 14-20 x 13-15 µm, thickwalled. All parts of the mycelium sulfonegative.
Plates covered in 4 weeks.

Code:
2a. 3c. 15b. 26. 34. 38. 44. 54. 55. 58.
Oxidase reactions:

Syringaldazine: -	Gum Guaiac +	Guaiacol +
1-Naphtol -	p-Cresol -	L-Tyrosine -

Polarity: Heterothallic but type of polarity unknown.

The occurrence of chlamydospores seems to be restricted to group II (easily detected in PS-cultures of all tested specimens in this group). Further, the growth is more rapid in group II (plates covered in 4 weeks) than in group III (plates not covered in 6 weeks).

Consequently, three distinct species can be distinguished within the *H. eichleri* complex, viz. *H. punctulatum*, *H. eichleri*, and *Hypochnus albostramineus*. The new combination *Hypochnicium albostramineum* (Bres.) Hallenb. n. comb. is therefore proposed. Basionym: *Hypochnus albostramineus* Bres., Ann. mycol. 1 p. 109, 1903.

The description of *H. eichleri* in Eriksson and Ryvarden (1976) includes *H. albostramineum*, while *H. eichleri* in the strict sense is segregated according to the discussion above and summarized in the key below. At the moment, the following can be said about habitat and distribution of *H. eichleri*:
The specimens in incompatibility group II have been collected on Betula, Alnus, Fagus, and Picea. The biotop has been wet and mossy or grass-rich Picea-forest, pure Betula-forest on a slope, and pure Fagus-forest. The specimens originate from Sweden, Norway, Scotland, and Romania. Specimens with the same spore sizes as in the intercompatibility group (*H. eichleri* sensu stricto), have been found among herbarium specimens under the name *H. eichleri*. At the moment, it does not seem possible to separate *H. eichleri* from *H. punctulatum* and *H. albostramineum* on criteria concerning distribution, biotop or substrate preference. On the other hand, *H. punctulatum* seems to be well separated from *H. albostramineum* on such criteria (Eriksson and Ryvarden, 1976).

KEY TO THE SPECIES IN THE H. EICHLERI COMPLEX.

1. Spores 5-6,5(-7) x 4,5-5,5 µm.........*H. punctulatum*
1. Spores bigger....................................2.
2. Spores 7-8(-8,5) x 5,5-7 µm, chlamydospores present in cultures.............................*H. eichleri*
2. Spores 8-10,5(-12) x 6-7(-9) µm, chlamydospores absent in cultures.................*H. albostramineum*

DISCUSSION. Specimens from the family Corticiaceae are usually determined on morphological characters of the fruitbody. However, the existence of "microspecies" which morphologically are very close, but genetically isolated from each other, may make it difficult to correctly determine herbarium material.
There are several possible explanations for incompatibility (species differentiation, identical incompatibility factors, differences in thallism, partenogenetic development, etc. - see Boidin, 1977; Esser and Hoffmann, 1977). Incompatibility as a result of species differentiation (genetically isolated populations) has hitherto been considered to be of importance for taxonomy. Populations which are genetically isolated from each other may be morphologically identical (sibling species) or different at a various degree. The genetical isolation may also be absolute or partial.

From a taxonomical view it seems reasonable to treat populations as belonging to different species when they are incompatible and when, in addition, distinguishing morphological characters exist. However, in nature all populations which are genetically isolated will behave like equally good species and in research which requires a strict genetical species concept these circumstances must be considered.

When there are distinguishing morphological characters between genetically isolated populations, these may be anything from distinct to hardly observable. The natural variation may also give rise to a considerable morphological overlap between two species. In fact, there are several species complexes where the included entities can be kept separate from each other in "typical cases" but where a number of specimens are "intermediate". However, it is an arbitrary way to classify specimens as "typical", "untypical", or "intermediate" as only the morphology of fruitbodies are considered.
The Hypochnicium eichleri complex is such a species aggregate. H. punctulatum is easily separated from H. albostramineum, while H. eichleri seems to be a well defined species which is widely distributed but with an uncertain morphological delimitation overlapping the other two.
For species complexes where incompatibility tests are possible to perform I recommend the use of a "narrow" species concept, considering that the populations concerned are incompatible and that morphological differences are noticeable at least in "typical cases". Further, for incompatible populations which morphologically are regarded as "siblings", there may be ecological differences but they should be distinct and easily observable before using them as species characters. When no cultures are available and determinations have to be based on morphology alone, "intermediate" specimens are better labeled e.g. Hypochnicium eichleri-punctulatum or H. eichleri-albostramineum.

Future research may enable us to add further characters of taxonomical importance. Such a development occurred in the species complex of Sistotrema brinkmannii (Bres.)John Erikss.
This species was long regarded as a complex consisting of incompatible but morphologically indistinguishable "microspecies". When new material of these "microspecies" was available in culture, a detailed morphological study of the different incompatibility groups showed that it really is possible to treat them as distinct species - also on morphological criteria alone (Hallenberg, 1984 a). Nevertheless, there still remains several species to be isolated and described within this complex.

Another example is Hyphodontia subalutacea (Karst.)John Erikss. (see Hallenberg, 1984 b). Specimens from N. Europe, collected on deciduous wood, were incompatible with specimens collected on coniferous wood. Both were - at least partially - compatible with N. American specimens. No morphological differences were observed between the tested specimens. They should therefore be regarded as "siblings" and carry the same binomial. However, when more material has been tested it may be proved that the ecological differences are constant and in such a case the different incompatibility groups in N. Europe could better be treated as distinct species in a taxonomic sense.

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COMPATIBILITY BETWEEN SPECIES OF CORTICIACEAE S.L. (BASIDIOMYCETES) FROM EUROPE AND CANADA. II.

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ABSTRACT. Intercompatibility has been proved between cultures from Canada and Europe for 6 corticiaceous species, viz. **Confertobasidium olivaceoalbum**, **Dacryobolus sudans**, **Hypochnicium polonense**, **Laeticorticium expallens**, **Mycoacia uda**, **Sistotremastrum suecicum**. Culture character are given for 4 of these species.

INTRODUCTION. This report is a continuation of an earlier study (Hallenberg 1984) where intercompatibility between specimens from North America and Europe was tested for more than 40 species (Corticiaceae). Background, discussion of results, information on methods applied, are more extensively dealt with in Hallenberg (1984). The essential points are summarized below.
The tests have been done to evaluate the species concept based on intercompatibility between specimens originating from different continents, while the specimens tested primarily have been determined on morphological criteria.
When specimens are compatible despite separation by a great geographical distance, it is most probable that they also are compatible with other specimens, not cultured from localities in between, i.e. the species is widespread.
Especial attention has been paid to fruitbody morphology of the tested specimens and observed differences are noted. However, conclusions about morphological variation must be taken with caution as the material tested is very limited.

This study is part of the flora-project "Corticiaceae of North Europe" and comments concerning taxonomy, morphology, etc. refer to the appropriate volume of that flora.

METHODS. Common malt agar (1,25 % malt extract) has been used as medium. Compatibility tests have been done by performing matings between single-spore (SS)-cultures from different specimens or between a polyspore (PS)-culture from one specimen and SS-cultures from another one (di-mon matings). Prior to these intercompatibility matings, the breeding ability of individual SS-cultures (i.e. the ability to form clamps in matings) have been determined. Normally, this has been done by mating the available SS-cultures

from one specimen in all combinations. Compatible mating types have then been used in intercompatibility matings between specimens as far as possible.
Characters of the PS-mycelium of six specimens have been studied. Drop tests for extracellular oxidases (Syringaldazine, Gum Guaiac, Guaiacol, 1-Naphtol, p-Cresol, L-Tyrosine) follow Marr's directions (1979); culture codes are from Nobles (1965) with emendations by Boidin and Lanquetin (1983 a). Nuclear staining has been made with Giemsa according to Boidin (1958).

RESULTS OF COMPATIBILITY TESTS WITH NOTES ON MORPHOLOGY OF FRUITBODIES AND CULTURES.

Data on specimens studied are categorized by slanted lines: Culture number/ substrate/ locality/ number of available SS-(PS)-cultures or SS-numbers of cultures belonging to compatible mating types. Compatible mating types are separated by a slanted line. Compatibility between two cultures are marked "+", incompatibility "-".

CONFERTOBASIDIUM OLIVACEOALBUM (Bourd. & Galz.) Jül.

Description, see Eriksson and Ryvarden (1973), p 259.

Material:
GB 375/ coniferous wood/ Austria, Steiermark/ 1/4.
GB 535/ Picea/ Canada, Quebec/ 1,4/2,3.

Compatibility between the two specimens. No noticeable morphological differences observed between the fruitbodies.

CULTURE CHARACTERS (GB 375, GB 535): Fig. 1, A-B.
Aerial mycelium cottony - woolly, pale yellowish, scattered subcultures due to dispersal of conidia. Advancing zone even, appressed. Hyphae with clamps at all septa, ordinarily branched, 1-3,5 µm wide, hyaline to pale yellowish, walls thin to slightly thickened, covered with minute crystals, soluble in KOH. Blastoconidia cylindrical, 5-9 x 2-2,5 µm, borne on undifferentiated hyphae.
Plates not covered in 6 weeks (45 mm in GB 375; 24 mm in GB 535).

CODE:
(1). (2a). 3c. 7. 33. 37. 38. 47. 55. 58. 61.
OXIDASE REACTIONS. All tests negative with exception for Gum Guaiac in GB 375.
POLARITY: Heterothallic but type of polarity unknown.
CYTOLOGY: SS-cultures with uninucleate cells, PS-culture constantly dicaryotic.
NUCLEAR BEHAVIOUR: Normal.

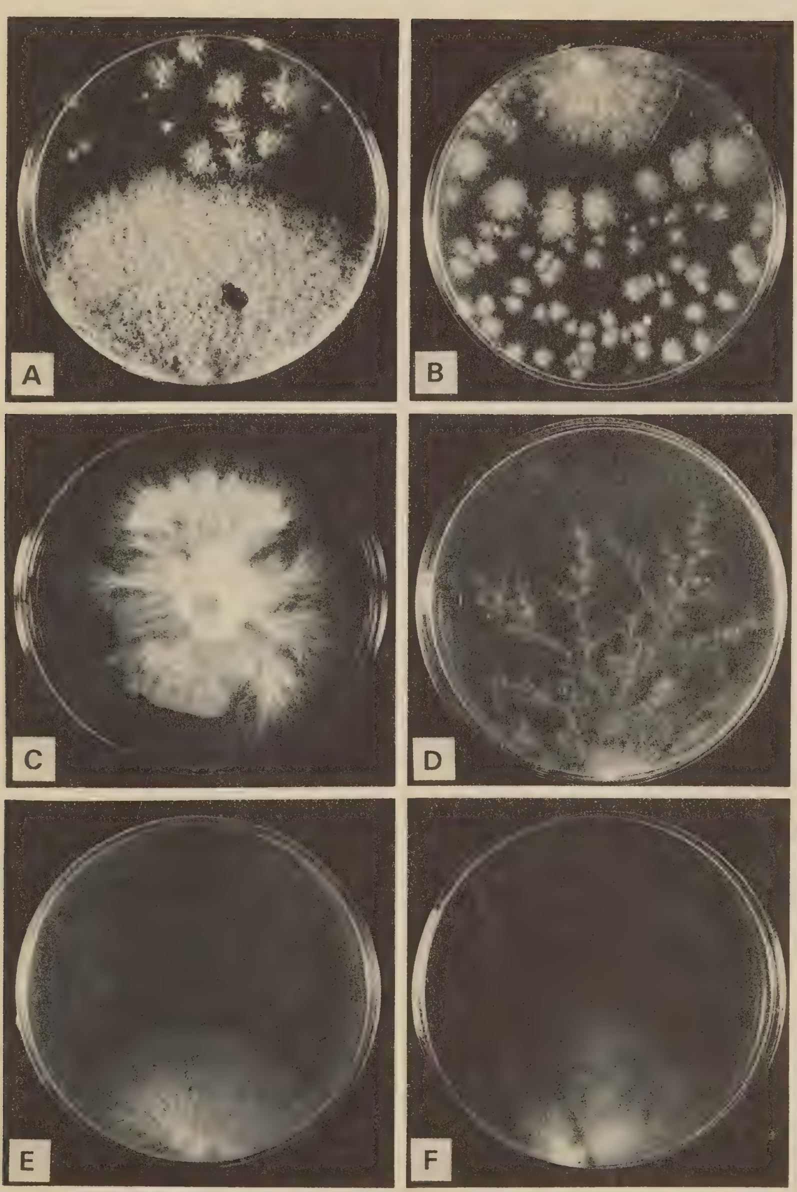

Fig. 1. Cultures after six weeks growth. A) **Confertobasidium olivaceoalbum**, GB 375, B) dito, GB 535, C) **Laeticorticium expallens**, GB 771, D) **Hypochnicium polonense**, GB 809, E) **Sistotremastrum suecicum**, GB 745, F) dito, GB 934. - Photos T. Hallingbäck.

DACRYOBOLUS SUDANS (Alb. & Schw.:Fr.)Fr.

Description, see Eriksson and Ryvarden (1975), p 347.

Material:
GB 742/ coniferous wood/ Canada, Ontario/ 1 PS.
GB 1064/ Picea/ Romania, Suceava/ 1,2/4.
GB 1340/ Picea/ Sweden, Gotland/ 5/2,3,4.

Compatibility between the European specimens (GB 1064 and GB 1340) and between GB 1064 and GB 742, incompatibility between GB 1340 and GB 742.
No noticeable micromorphological differences observed between the fruitbodies. The collected specimens are, however, of different ages and the development of the teeth on the hymenial surface is thus variable. GB 1064 is a young specimen with scattered, single, and slender teeth, while GB 1340 is fully mature with teeth which are relatively big and crowded.
POLARITY: **D. sudans** is tetrapolar (Biggs, 1938).

HYPOCHNICIUM POLONENSE (Bres.)Strid

Description, see Eriksson and Ryvarden (1976), p 717.

Material:
GB 809/ deciduous wood/ Canada, Ontario/ 1/2.
GB 942/ Ulmus/ Norway, N. Tröndelag/ 1,2/5.

Compatibility between the two specimens. No noticeable morphological differences between the fruitbodies. Both specimens were collected in fertile, herbaceous, deciduous forests containing Ulmus.

CULTURE CHARACTERS (GB 809): Fig. 1, D.
Aerial mycelium downy - almost absent, mat plumose. Advancing zone fringed, appressed. Hyphae with clamps at all septa, ordinarily branched, 3-7 µm wide, content grainy, oilrich, some hyphal endings slightly capitate. In old mat hyphae frequently with an irregular outline (constrictions, expansions).
Plates not covered in 6 weeks (60 mm).

CODE:
1. 3c. 26. 32. 36. 38. 47. 54. 58. 61.
OXIDASE REACTIONS: All tests negative.
POLARITY: Heterothallic but type of polarity unknown.
CYTOLOGY: SS-mycelium with uninucleate cells, PS-mycelium dicaryotic.
NUCLEAR BEHAVIOUR: Normal.

LAETICORTICIUM EXPALLENS (Bres.) Erikss. & Hjortst.

Description, see Eriksson et al (1981), p. 1069.

Material:
GB 771/ deciduous wood/ Canada, Ontario/ 2/3.
GB 896/ Fagus/ Denmark, Jylland/ 1,2,4/3,5.

Compatibility between the two specimens. Fruitbodies very similar, differing slightly, however, in spore length (5-6 µm in GB 771; 6-7 µm in GB 896; according to Eriksson et al, 1981, 6-8 µm).

CULTURE CHARACTERS (GB 771): Fig. 1, C.
Aerial mycelium woolly, plumose. Advancing zone fringed, appressed. Hyphae with clamps at all septa, ordinarily branched, 1,5-5 µm wide, thin-walled. Gloeocystidia in old mat, cylindrical - napiform, 12-25 x 5,5 - 12 µm, content light-refracting in phase, yellowish, sulfo-negative. Plates not covered in 6 weeks (40 mm).

CODE:
2a. 3c. 15b. 32. 36. 38. 47. 54. 58. 61.
OXIDASE REACTIONS: All tests negative with exception for Gum Guaiac.
POLARITY: Heterothallic but type of polarity unknown.
CYTOLOGY: SS-mycelium with uninucleate cells, PS-mycelium dicaryotic.
NUCLEAR BEHAVIOUR: Normal.

REMARKS. The generic position of **L. expallens** has been regarded as indistinct (Boidin and Lanquetin, 1983 b). Boidin and Lanquetin assign the species with rose-coloured, binucleate spores, and bipolar heterothallism (sometimes homothallism) to one genus (**Corticium** Pers.). The whitespored, tetrapolar ones are placed in **Dendrocorticium** Larsen & Gilbn. emend. Boid. & Lanq. (= **L. polygonioides**-group in Eriksson, Ryvarden, 1976).
The specimens studied here had a white spore-print, while the polarity is unknown because too few SS-cultures were available. Thus, it is not possible to give **L. expallens** a more distinct generic or suprageneric place and it is refered to **Laeticorticium** in the wide sense adopted by Eriksson and Ryvarden (1976).

MYCOACIA UDA (Fr.)Donk

Description, see Eriksson and Ryvarden (1976), p 885.

Material:
GB 668/ Alnus/ Canada, British Columbia/ 1 SS, 1 PS.
GB 707/ decid. wood/ Canada, British Columbia/ 1 SS, 1 PS.
GB 1194/ Alnus/ Norway, Sogn and Fjordane/ 1/3,4.
GB 1326/ Ulmus/ Sweden, Västergötland/ 3 SS.

Compatibility between GB 1194 and the Canadian specimens, while some matings with GB 1326 lacked clamp formation:

	GB668-1	GB707-1	GB1194-1	GB1194-3	GB1326-1	GB1326-2
GB 668-1		-	+	+	-	+
GB 707-1			+	+	-	+
GB 1194-1					-	-
GB 1194-3					+	+
GB 668-PS		+			+	+
GB 707-PS	+					

The negative results in the matings between the Canadian specimens can probably be explained by identical incompatibility factors. The two specimens were collected a few kilometers from each other (around Cowichan Lake, Vancouver Island) and clamps were formed in di-mon matings between them. The negative results with GB 1326 could, however, be explained by partial heterogenic incompatibility (Esser, 1973).
Fruitbody characters were a little variable between the tested specimens. The teeth are thin, slender and separated from each other in all specimens except GB 707, where they are thicker and somewhat aggregated (which may depend on different ages of the fruitbodies). The fruitbody in GB 1194 is reddish, while citric yellowish - light ochraceous in the other specimens. The spores (when measured from spore prints) are a little longer in GB 1326 (4,5-5,5 µm) than in GB 1194 (4,5-5 µm). Fruitbody tissue in all tested specimens turned red when treated with KOH and all of them had the same kind of cystidioles and the same rod-like shape of crystals on tramal hyphae.
According to Boidin and Lanquetin (1984) **M. uda** is bipolar with an astatocoenocytic nuclear behaviour.

SISTOTREMASTRUM SUECICUM Litsch. in John Erikss.

Description, see Eriksson et al (1984), p 1377.

Material:
GB 745/ Pinus/ Canada, Ontario/ 1,3/2.
GB 934/ Pinus/ Scotland, Perthshire/ 1,2,6/3,4,7.

Compatibility between the two specimens. No noticeable morphological differences between their fruitbodies.

CULTURE CHARACTERS (GB 745, GB 934): Fig. 1, E-F.
Aerial mycelium absent, downy - cottony in old parts. Advancing zone even, appressed. Hyphae with clamps at all septa, ordinarily branched but some slightly differentiated to form strands, 1,5-5 µm wide, with thin to slightly thickened walls, content partly grainy, oilrich, in old mat scattered moniliform hyphae and capitate hyphal endings.
Plates not covered in 6 weeks (30 mm in GB 745; 40 mm in GB 934).

CODE: (1). (2a). (7). (26). 32. 36. 38. 47. 55. (59). 61.
OXIDASE REACTIONS:

	Syringald.	1-Naphtol	Gum Guaiac	Guaiacol	p-Cresol	L-Tyr.
GB 745	+	+	+	+	-	-
GB 934	-	-	-	-	-	-

POLARITY: Heterothallic but type of polarity uncertain because of a small number of available SS-cultures (bipolarity indicated).
CYTOLOGY: SS-mycelium with uninucleate cells, PS-mycelium mainly dicaryotic, terminal cells frequently with 3-4 nuclei.
NUCLEAR BEHAVIOUR: Normal, but with some irregularities.

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BOTRYOSPHAERIA AND FUSICOCCUM SPECIES ASSOCIATED WITH RIPE FRUIT ROT OF ACTINIDIA DELICIOSA (KIWIFRUIT) IN NEW ZEALAND

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ABSTRACT

Three cultural types of *Fusicoccum* Corda that fell within the broad concept of the anamorph of *Botryosphaeria dothidea* (Mougeot ex Fries) Cesati & de Notaris were isolated repeatedly from ripe fruits of *Actinidia deliciosa.* They were stable taxa occurring together over a wide geographic range, and differing in their cultural characteristics (including conidial size and shape), in the stage of fruit ripeness at which their lesions first developed, and in their sensitivity to benzimidazole fungicides. Cultures of conidial and single ascospore isolates from *Fusicoccum* and *Botryosphaeria* Cesati & de Notaris fructifications found abundantly in kiwifruit orchards were identical with two of the cultural types from fruit rots. These two cultural types corresponded to small, but consistent, differences in ascospore size. The fungi are described as: *B. dothidea* (anamorph = *F. aesculi* Corda); *B. parva* sp. nov. (anamorph = *F. parvum* sp. nov.); and *F. luteum* sp. nov. All three species had phialidic conidiogenesis, with the conidiogenous cells proliferating percurrently, but first-formed conidia appeared to be produced holoblastically. Because the current concept of *Fusicoccum* is probably based on such first-formed conidia, the generic concept is modified to include phialidic conidiogenesis; *Macrophomopsis* Petrak is synonymised with *Fusicoccum*, and *M. coronillae* (Desmazières) Petrak, the type species, is a taxonomic synonym of *F. aesculi.*

INTRODUCTION

In New Zealand, berries of *Actinidia deliciosa* (Chevalier) Liang & Ferguson (1984; syn. *A. chinensis* Planchon var. *hispida* Liang; kiwifruit) are harvested in autumn (May) when they are mature but unripe. Export quality fruits are graded, packed in polyethylene-lined trays, and stored at 0°C for a period of up to 6 months depending on the requirements of markets in Europe, North America, Asia, and Australia. Development of good eating qualities requires a short, post-storage period of ripening at ambient temperature. Once ripening has begun, most fruits eventually develop rot lesions from latent infections established in the orchard during the growing season. If the ripening fruits are retained within the storage trays, or otherwise poorly ventilated, both fruit ripening and development of additional lesions are markedly accelerated by copious production of ethylene from the rots.

Although several fungi have been isolated from these lesions (Hawthorne, Rees-George, & Samuels, 1982), the most frequently involved are *Colletotrichum acutatum* Simmonds, and a small number of culturally distinct species of *Fusicoccum* Corda and *Phomopsis* (Saccardo) Saccardo. The *Fusicoccum* species are discussed in this paper, together with species of *Botryosphaeria* Cesati & de Notaris and *Fusicoccum* found as fructifications in kiwifruit orchards.

MATERIALS & METHODS

Fruit rot isolations were made on to plates of prune agar (PrA; Difco) amended with streptomycin sulphate (40 mg/l), from lesions exposed by peeling back the skin aseptically. Initial identifications were made after 6 days of incubation at c. 20°C under cycles of 12 h darkness: 12 h near-ultraviolet and visible illumination ('BLB' and 'Cool White' fluorescent tubes). Radial growth rates and temperature responses of cultures were measured on 85 mm diam. potato dextrose agar (PDA; Difco) plates, each inoculated at one edge with a 4 mm diam. plug taken from an actively growing colony. Responses of cultures to benzimidazole fungicides were determined on plates of malt extract agar (MEA; Gibco) amended with carbendazim (technical grade; DuPont) dissolved in 0.1N HCl; each plate was inoculated with 4-5 plugs, each from an actively growing colony of a different isolate. Single ascospores were isolated with the aid of a micromanipulator, and germinated on cornmeal dextrose agar (CMD; Difco). Characteristics in culture were recorded on CMD, PDA, PrA, oatmeal agar (OA; Difco) and Czapek-Dox agar (CDA; Difco). All measurements of spores were from material mounted in 100% lactic acid. Dried cultures are deposited in the herbarium of Plant Diseases Division (PDD); living cultures are deposited in the Plant Diseases Division Culture Collection (PDDCC) and the American Type Culture Collection (ATCC).

RESULTS

Fruit rot symptoms and isolates

The symptoms observed at an early stage of ripening were distinctive, large (up to c. 30 mm long), usually solitary, pale brown, oval lesions with a narrow, glassy, dark green margin (Pennycook, 1981, 1985); in some years these occurred mainly on the side of the fruits, but in other years mainly on the distal end, centred on the senescent styles. Symptoms developing at later stages of ripening consisted of numerous, smaller, more variable lesions, which in over-ripe fruits often formed a confluent mosaic of rots.

Isolations over a 4 year period from thousands of ripening kiwifruits grown in the Te Puke (Bay of Plenty, North Island) and

Kumeu (Auckland, North Island) districts have yielded a few isolates of the anamorph of *Botryosphaeria stevensii* Shoemaker (not dealt with further in this paper), and numerous isolates that were morphologically indistinguishable from the anamorph of *Botryosphaeria dothidea* (Mougeot ex Fries) Cesati & de Notaris, as described by Punithalingam & Holliday (1973; as *B. ribis* Grossenbacher & Duggar), Kobayashi & Oishi (1979), and Sutton (1980; as *Fusicoccum aesculi* Corda). However, in agar culture these latter isolates fell into three distinct cultural types, each with a consistently smaller range of conidial sizes than is generally reported for the *Fusicoccum* anamorph of *B. dothidea* (see summary in Kobayashi & Oishi, 1979).

Each sample of affected kiwifruits yielded at least two, and usually all three, of the cultural types. However, the three fungi differed in the stage of fruit ripeness at which their lesions began to develop. The distinctive early lesions almost invariably yielded a cultural type with long, fusiform conidia (Fig. 2.2; mean size 23.1 x 5.4 µm), which we have identified as *Fusicoccum aesculi*. This fungus was isolated less frequently from the smaller, later-developing lesions, and rarely from lesions that first appeared on over-ripe fruits. A small proportion of the distinctive early lesions yielded a cultural type, *F. parvum* sp. nov., with shorter, ellipsoidal conidia (Figs 2.7, 2.8; mean size 16.0 x 5.9 µm), but this fungus was more frequently isolated from the later small lesions on ripe and over-ripe fruits. A third cultural type, *F. luteum* sp. nov., with longer, ellipsoidal to fusiform conidia (Fig. 2.12; mean size 21.7 x 6.7 µm), was usually isolated from lesions that first appeared on over-ripe fruits, and rarely from earlier symptoms. (*F. luteum* has also been isolated frequently from storage rots on apple fruits, and once from lenticel spots on a pear fruit.)

The three species could usually be distinguished on PrA isolation plates before they began to sporulate. Useful distinguishing features of 6-day-old colonies were: *F. aesculi* - slimy in appearance, lacking aerial mycelium, translucent, with some dark hyphae and dark brown pycnidial initials; *F. parvum* - dense opaque black mycelial felt, with marked diurnal zonation, and pycnidial initials sparse or lacking; *F. luteum* - translucent, sparse yellowish-white to pale brown aerial mycelium with numerous pycnidial initials, and yellow pigment diffusing into the medium.

Teleomorph and anamorph fructifications

Fructifications of *Botryosphaeria* and *Fusicoccum* were found infrequently on old kiwifruit prunings that had been left to lie on the ground in the orchards, but abundantly on small, dead branches of *Populus nigra* Linnaeus (lombardy poplar) trees in orchard shelterbelts.

Conidia isolated from pycnidia that were morphologically and anatomically indistinguishable from each other produced cultures identical with either *F. aesculi* or *F. parvum* obtained from fruit rots. The size difference between conidia developing in cultures of the two species was also apparent in conidia from the field. (Pycnidia that produced cultures of *F. parvum* have also been found in apple twigs.)

Single ascospores isolated from ascomata on kiwifruit prunings and poplar branches also produced cultures of either *F. aesculi* or *F. parvum*. The two categories of ascomata were morphologically and anatomically indistinguishable from each other, but there were small, but consistent, differences in ascospore size; the larger ascospores (*B. dothidea*; Fig. 2.1; mean size 22.8 x 9.3 μm) yielded cultures of *F. aesculi*, whereas the smaller ascospores (*B. parva* sp. nov.; Fig. 2.6; mean size 20.8 x 9.2 μm) yielded cultures of *F. parvum*.

We have not found either sexual or asexual fructifications of *F. luteum* in the field.

Radial growth rates and temperature responses of cultures

Temperatures of 28-29°C were optimal for radial growth of PDA cultures of all three *Fusicoccum* species (Fig. 1). Maximal growth rates were: *F. aesculi* 11.1 mm/day; *F. parvum* 18.2 mm/day; *F. luteum* 21.4 mm/day. At most temperatures, cultures of *F. parvum* and *F. luteum* grew significantly faster than those of *F. aesculi*. However, *F. parvum* and *F. luteum* failed to grow at 35°C whereas *F. aesculi* continued to grow quite rapidly. None of the cultures grew at temperatures below 10°C; but all remained viable at 0°C, growing at a normal rate when returned to 25°C after 72 h.

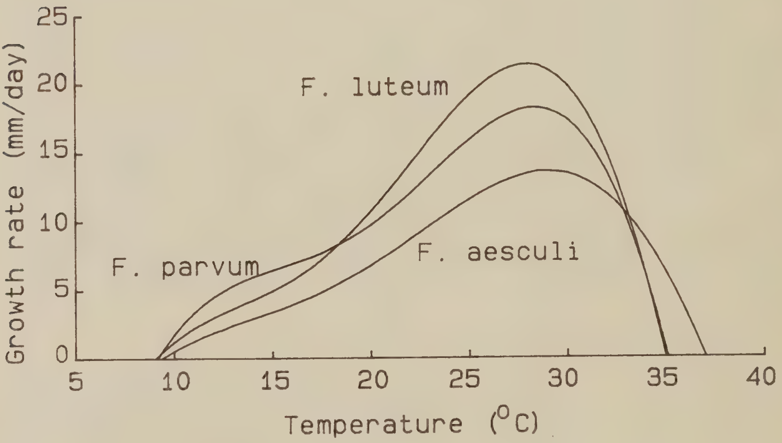


Figure 1. Radial growth rates of *Fusicoccum* cultures. Three replicate colonies x three isolates of each species were grown in darkness on potato dextrose agar plates at 10, 15, 20, 25, 30, and 35°C (all ± 0.5°); radial growth of each colony was measured daily on two pre-marked radii at right angles. Curves were fitted by Fourier analysis of growth increments between days 1 and 3 after inoculation.

Benzimidazole sensitivity of cultures

All isolates tested were relatively sensitive to carbendazim, with EC_{50} values for radial growth rate well below 1 mg/l (Table 1). However, cultures of *F. aesculi* were significantly more tolerant of carbendazim than those of *F. parvum* and *F. luteum*; all isolates of *F. aesculi* had made considerable radial growth after 3 days on 1 mg/l (17-41% of control; with well developed aerial mycelium) and after 19 days on 100 mg/l, whereas all isolates of the other two species made either limited, or no, growth under the same conditions.

Table 1. Benzimidazole sensitivity of *Fusicoccum* cultures. Daily measurements of radial growth were made on two replicate colonies of each isolate growing in darkness at 20°C on malt extract agar (MEA) amended with carbendazim (MBC) at 0, 0.1, 1, 10, and 100 mg/l, and on one replicate on MEA + 0.01 mg/l. Radial growth rates (mean & range) were calculated by least-squares analysis of growth increments between days 1, 2, and 3 after inoculation; EC_{50} values (mean & 95% confidence interval) were calculated by logistic analysis of radial growth rate versus log fungicide concentration; radial growth data are cited as mean & range.

Fusicoccum species	Radial growth rate (mm/d) on MBC 0 mg/l	Radial growth rate (mm/d) on MBC 1 mg/l	EC_{50} (mg/l)	Radial growth (mm) after 19 d on MBC 100 mg/l
F. aesculi (12 isolates)	6.7 (6.0-7.8)	1.8 (1.1-2.5)	0.19 (0.14-0.27)	8.9 (7-13)
F. parvum (7 isolates)	11.4 (10.5-12.5)	0.9 (0.4-1.7)	0.09 (0.08-0.11)	3.4 (2-6)
F. luteum (10 isolates)	10.1 (9.5-10.5)	0.3 (0-0.6)	0.11 (0.10-0.12)	0.0 (0-1)

DISCUSSION

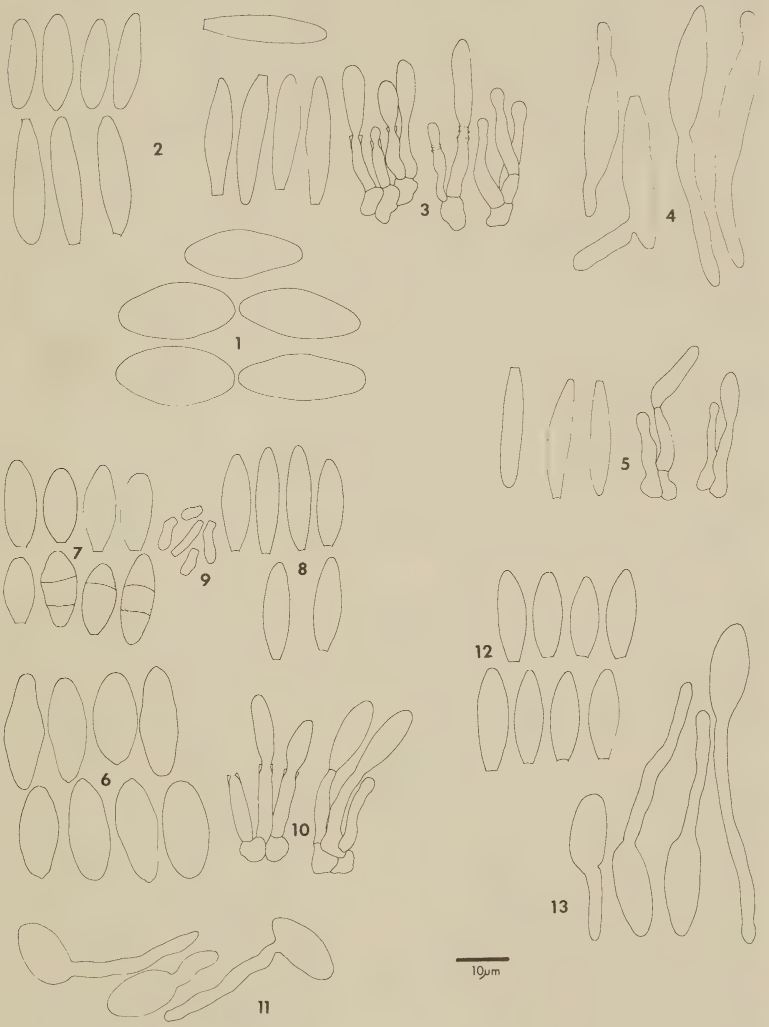
The three cultural types of *Fusicoccum* are stable taxa which occur together over a wide geographic range. They have been isolated over a period of years from hundreds of lesions occurring on kiwifruits grown in two widely separated areas (c. 190 km apart). They differ in the stage of fruit ripeness at which their lesions first develop, and in their sensitivity to benzimidazole fungicides. Each corresponds to a well defined range of conidial measurements, and two of them to well defined ranges of ascospore measurements. We therefore conclude that they constitute two species of *Botryosphaeria* (*B. dothidea* and *B. parva* sp. nov.) with *Fusicoccum* anamorphs (*F. aesculi* and *F. parvum* sp. nov., respectively), and an additional species of *Fusicoccum* (*F. luteum* sp. nov.).

In the current concept of *Fusicoccum aesculi* (Sutton, 1980), conidia are produced holoblastically on non-proliferating conidiogenous cells; each conidiogenous cell therefore produces only one conidium; conidia are fusiform, hyaline, and aseptate, and have a distinctly truncate base. The conidia that we have observed for the three fungi discussed here concur in morphology with what is usually described for *F. aesculi*. However, conidia of *B. parva* and *F. luteum* have smaller length/width ratios than those of *F. aesculi*, and tend to be ellipsoidal rather than fusiform; ungerminated conidia of *B. parva* become pale brown and 2-3-septate with age (Fig. 2.7), and conidia of *F. luteum* remain colourless but may develop 1-2 septa. Maas & Uecker (1984) identified *B. dothidea* as a cause of canker in thornless blackberry (*Rubus* spp.). The conidia that they described were shorter and broader (16.5-20 x 6.3-8 μm) than we have found for *B. dothidea*, and became pale brown and septate prior to germination. These observations agree with what we have found for *B. parva*; conidia of *B. dothidea* arising in our cultures derived from ascospores remained colourless and aseptate at germination.

Conidiogenous cells in young pycnidia of our three species appear to be determinate, and conidiogenesis appears to be holoblastic. No periclinal thickening can be seen at the tip of the conidiogenous cell and the apparently mature conidium is clearly delimited from the conidiogenous cell by a septum. However, in older pycnidia (those with oozing conidia), conidiogenous cells are conspicuously thickened at the tip and the conidiogenous locus proliferates for a short distance to form 2-3 irregularly shaped annellations (Figs 2.3, 2.10, 3). This apparent discrepancy in conidiogenesis is easily accommodated in the concept of the phialide as it is currently understood, i.e. the first conidium forms as the blown out end of a conidiogenous cell whereas the wall of subsequently formed conidia forms de novo within the tip of the conidiogenous cell (Kendrick, 1971; Minter, Kirk, & Sutton, 1982). Maas & Uecker (1984) illustrated phialides in the *Fusicoccum* species that they identified as the anamorph of *B. dothidea* (see above).

The type specimen of *Fusicoccum aesculi* cannot be located. Dr M. Svrček (Prague) has informed us that material of this species is not in Corda's herbarium in Prague and, according to Sutton (1980), there are no reports of anyone having re-examined Corda's original material. Sutton's (1980) concept of *F. aesculi* is based on a Saccardo specimen

Figure 2. 1-4: *Botryosphaeria dothidea*. (1: Ascospores, PDD 45432; 2: Conidia, left = PDD 45432, right = PDD 44374; 3: Conidiogenous cells, PDD 44374; 4: Conidia germinating within 4 h on CMD at 20°C, PDD 45431). 5: *Fusicoccum aesculi*. Conidia and conidiogenous cells, ex PAD. 6-11: *B. parva*. (6: Ascospores, PDD 45438 (type); 7: Conidia, ex culture, PDD 45438; 8: Conidia, ex nature, PDD 45438; 9: "Spermatia", ex culture, PDD 45438; 10: Conidiogenous cells, left = PDD 44388, right = PDD 45405; 11: Conidia germinating within 4 h on CMD at 20°C, PDD 45405). 12-13: *F. luteum*. (12: Conidia, PDD 45400 (type); 13: Conidia germinating within 4 h on CMD at 20°C, PDD 45400).


10µm

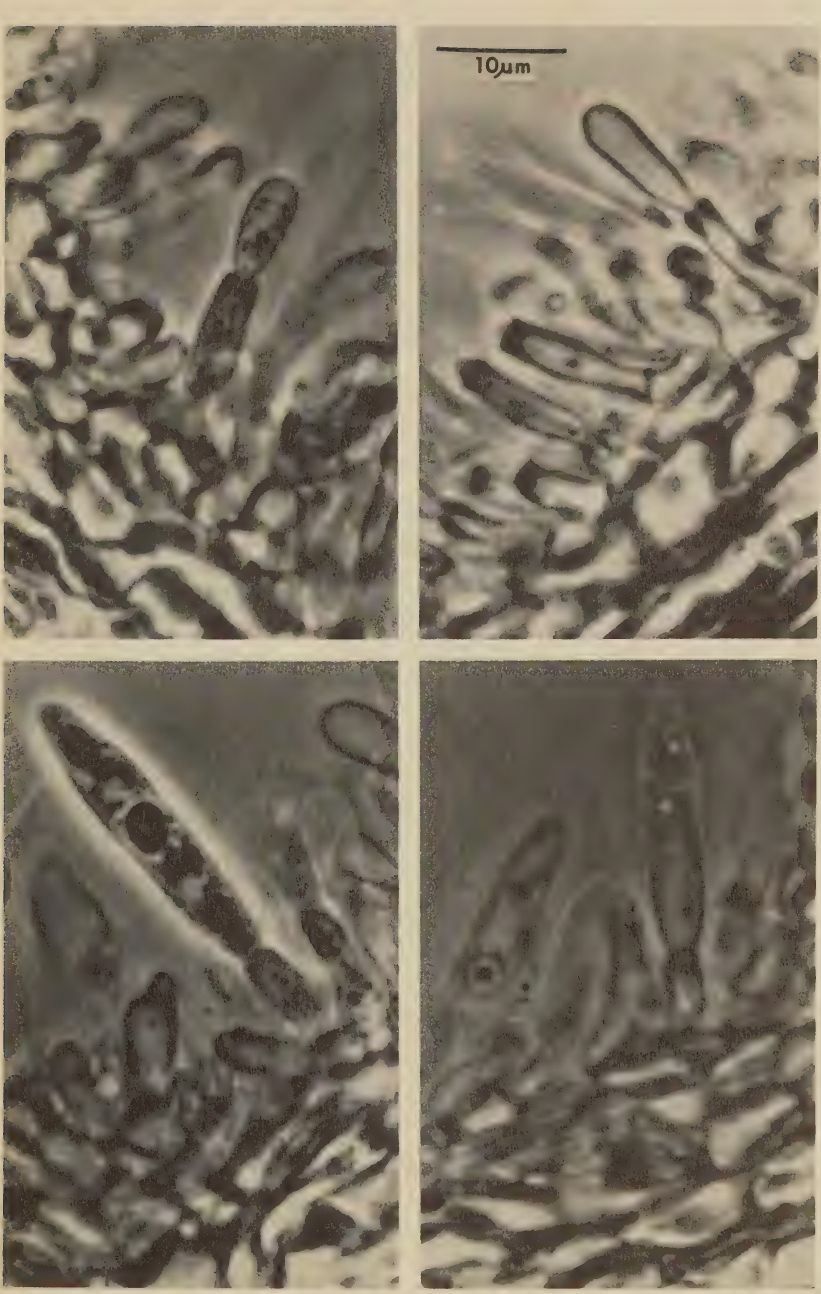
from *Aesculus* sp. in Italy (PAD). We have examined the Saccardo specimen and agree with Sutton (1980) that conidiogenesis appears to be holoblastic (Fig. 2.5); the conidia are narrowly fusiform with a truncate base, measure 23-30 x 4-5 µm, and are colourless and aseptate. However, we believe Saccardo's specimen to be immature, because the pycnidia are covered by raised areas of bark; there are no erumpent pycnidia. Thus the current concept of *F. aesculi* (sensu Sutton, 1980) is probably based on observations of first-formed conidia. Because *F. aesculi* is the type species of *Fusicoccum* Corda, the generic concept must be expanded to include species having pycnidia and conidia like those of *F. aesculi* (sensu Sutton, 1980), but with phialidic conidiogenous cells that may proliferate percurrently.

The concept of *Fusicoccum* modified to include phialidic conidiogenesis encompasses the concept of *Macrophomopsis* Petrak. According to Sutton (1980), conidia of the type species, *M. coronillae* (Desmazières) Petrak, form from phialides, and percurrent proliferation through the conidiogenous locus gives the conidiogenous cells an annellate aspect; this is the only feature which distinguishes *M. coronillae* from *F. aesculi* (Sutton, 1980). In the light of our results, *M. coronillae* is a later taxonomic synonym of *F. aesculi*, and *Macrophomopsis* is a synonym of *Fusicoccum*.

Botryosphaeria dothidea is ubiquitous on a wide variety of usually woody plants (Punithalingam & Holliday, 1973; McGlohon, 1982), causing dieback or cankers on stems and also postharvest fruit rots. We have seen only three descriptions of *B. dothidea* in culture: Grossenbacher & Duggar (1911) and Shear, Stevens, & Wilcox (1924) found that strains parasitic to currant (*Ribes* spp.) produced a diffusing red pigment on 'starchy medium', whereas non-chromogenic strains were saprobic; Putterill (1919) reported reddish pigmentation in cultures of strains causing apple canker in South Africa. Dark-grown PDA cultures of our *F. luteum* isolates developed a dull violaceous pigmentation, but only some days after the conspicuous production of a vivid yellow pigment. Earlier writers did not record any yellow pigmentation. In New Zealand, only the two non-chromogenic species (*B. dothidea* and *B. parva*) were isolated from dead branches of *Populus nigra*, and both caused lesions on kiwifruits at an earlier stage of ripening than the chromogenic *F. luteum*. Thus chromogenesis does not appear to be an indicator of pathogenic ability in these species.

Botryosphaeria dothidea, *B. parva*, and *Fusicoccum luteum* are distinguished from each other on the basis of a combination of characters, the most obvious of which are conidial size and pigmentation in culture. In the absence of cultures it would be difficult to differentiate the three. Arx & Müller (1954) cited extensive synonymy for *B. dothidea*, but this was based on study of herbarium specimens alone. From the wide range of conidial measurements attributed to *B. dothidea* (summarised by Arx & Müller, 1954; and Kobayashi & Oishi, 1979) and from our cultural work, we conclude that *B. dothidea* sensu lato is a widespread species complex.

Figure 3. *Botryosphaeria parva*. Conidia and conidiogenous cells, PDD 44388.


10μm

Recognition of this is of more than academic interest, given the different pathogenic behaviour of *B. dothidea*, *B. parva*, and *F. luteum*, and their different sensitivities to benzimidazole fungicides.

DESCRIPTIONS OF THE SPECIES

1. **Botryosphaeria dothidea** (Mougeot ex Fries) Cesati & de Notaris, 1863, Commentario della Societa Crittogamologica Italiana 1: 215. [Figs 2.1-2.4]
   = *Sphaeria dothidea* Mougeot ex Fries, 1823, Systema Mycologicum 2: 423.
  Anamorph: *Fusicoccum aesculi* Corda, in Sturm, 1829, Deutschlands Flora 2: 111.
   = *Macrophomopsis coronillae* (Desmazières) Petrak, 1924, Annales Mycologici 22: 108.
   = *Sphaeria coronillae* Desmazières, 1840, Annales des Sciences Naturelles, Botanique, 2e sér., 13: 188.

Ascomata forming in caespitose, stromatic clusters 2-5 mm in greatest dimension; each cluster comprising 5-50(-100) ascomata, erumpent through bark, surface of aggregate nearly level with surface of bark or somewhat sunken; cells of stroma pseudoparenchymatous, upper 1/4 of individual ascomata evident. Ascomata globose, non-papillate or with a short, conical papilla, black, smooth, not collapsing when dry; locules 150-250 µm diam., contents conspicuously white when dry. Asci clavate, 8-spored, bitunicate, (65-)75-112(-140) x (16-)18-20(-21) µm. Ascospores ellipsoidal to fusoid, often with a minute apiculus at each end, (13-)19-27(-35) x (6-)8-11(-14) µm [mean ± standard deviation of 255 ascospores = 22.8 ± 3.8 x 9.3 ± 1.4 µm; L/B = 2.5], unicellular, hyaline, smooth.

CHARACTERISTICS IN CULTURE. Colonies grown 3 weeks at 20°C in diffuse daylight; on PDA and OA, aerial mycelium cinereous; on PDA, forming scattered, hyphal, rope-like strands, with individual strands not reaching lid of Petri dish; on CDA, yellow discoloration forming in aerial mycelium, uniformly felty, lacking rope-like strands. Pycnidia forming within 9 days at 20°C with 12 h darkness: 12 h near-ultraviolet and visible illumination. On PrA, pycnidia sparse, uniformly distributed, most immersed; superficial pycnidia solitary or forming globose aggregates 1-1.5 mm diam.; individual pycnidia globose, non-papillate or with a conical papilla, 100-300 µm diam., with pale olivaceous hyphae arising from the pycnidial wall; conidia oozing from some pycnidia after 9 days. On PDA, pycnidia numerous, scattered, uniformly distributed, most immersed; superficial pycnidia clothed in flexuous, yellow-olivaceous hyphae, solitary or forming globose aggregates 1-1.5 mm diam.; individual pycnidia globose, non-papillate, 800-1000 µm diam., not associated with blackening of the colony surface; conidia oozing from some pycnidia within 9 days. Conidia fusiform with a flat or round base, (15-)20-26(-32) x (4-)5-6(-9) µm [mean ± standard deviation of 571 conidia = 23.1 ± 2.8 x 5.4 ± 0.6 µm; L/B = 4.3], unicellular, smooth, hyaline, not becoming light brown or septate with age.

ILLUSTRATIONS. Kobayashi & Oishi (1979).

REPRESENTATIVE SPECIMENS EXAMINED. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 1 Road, DSIR Research Orchard, on *Populus nigra*, Pennycook, 17 Dec 1981 (PDD 42971 = PDDCC 8019; PDD 45432 = ATCC 58223; PDD 42969); same locality, on *P. nigra*, Samuels & Pennycook, 23 Dec 1981 (PDD 42967); same locality, on *P. nigra*, Pennycook & Manning, 17 Nov 1983 (PDD 45431 = ATCC 58188); Te Puke, No. 3 Road, Baldwin orchard, on *P. nigra*, Pennycook, 17 Dec 1981 (PDD 42970); Te Puke, No. 3 Road, Vincent orchard, on *P. nigra*, Samuels & Pennycook, 15 Jul 1981 (PDD 45433); Te Puke, No. 1 Road, DSIR Research Orchard, on prunings of *Actinidia deliciosa*, Samuels & Pennycook, 21 Jun 1982 (PDD 44374 = PDDCC 8017).

ADDITIONAL CULTURES EXAMINED. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 1 Road, DSIR Research Orchard, from lesions on ripe fruit of *A. deliciosa*, Pennycook, Sep-Oct 1982 (PDD 45434 = PDDCC 7930, 7931, 8015; PDD 45436 = PDDCC 8011, 8012; PDD 45437 = PDDCC 7929 = ATCC 58187).

2. **Botryosphaeria parva** Pennycook & Samuels, sp. nov.

[Figs 2.6-2.11, 3]

Botryosphaeriae dothideae similis sed ascosporis minoribus (18-23 x 8-10 μm).
Holotypus: PDD 45438.
Status anamorphosus: *Fusicoccum parvum* Pennycook & Samuels, sp. nov.
Fusicocco aesculi similis sed conidiis minoribus (14-18 x 5-7 μm).
Holotypus: PDD 45438.
Status teleomorphosus: *Botryosphaeria parva* Pennycook & Samuels.

Ascomata and pycnidia formed within the same stromatic mass. Ascomata morphologically indistinguishable from those of *B. dothidea*. Asci as found in *B. dothidea*, 75-143(-210) x 17-21 μm. Ascospores broadly ellipsoidal to fusoid, often with an apiculus at each end, (14-)18-23(-26) x (7-)8-10(-11) μm [mean ± standard deviation of 73 ascospores = 20.8 ± 2.3 x 9.2 ± 0.9 m; L/B = 2.2], hyaline, smooth. Pycnidial aggregates morphologically indistinguishable from ascomatal aggregates; several pycnidia in each aggregate. Pycnidia globose and non-papillate to pyriform with a short, acute papilla; pycnidium merely a locule (100-150 μm diam.) created within stromal tissue; pycnidial wall not differentiated from surrounding tissue, and conidiogenous cells arising directly from stromal cells; entire locule lined with conidiogenous cells; locules opening through a pore lined with conidiogenous cells; immersed locules may coalesce and discharge through a common pore. "Spermatia" formed in the same locule with macroconidia, but more abundant in the apex of the locule and the ostiolar opening.

CHARACTERISTICS IN CULTURE. Colonies grown 3 weeks at 20°C in diffuse daylight; on PDA and OA, aerial mycelium grey with prominent, hyphal, rope-like strands reaching lid of Petri dish; on CDA and PrA, rope-like strands present, but less well developed. Pycnidia forming within 9 days at 20°C with 12 h darkness: 12 h near-ultraviolet and visible illumination. On PrA, pycnidia scattered but mainly peripheral, most immersed, solitary or forming aggregates less than 0.5 mm diam.; individual pycnidia globose, non-papillate, 190-250 µm diam., not conspicuously clothed in hyphae; conidia not oozing within 9 days. On PDA, pycnidia uniformly distributed but obscured by aerial mycelium except in center of colony; superficial pycnidia solitary, not aggregated, globose, non-papillate, 400-600 µm diam., glabrous or clothed in short, olivaceous hyphae; conidia oozing from some pycnidia within 9 days. Conidia ellipsoidal with apex round and base flat, (11-)14-18(-23) x 5-7(-10) µm [mean ± standard deviation of 371 conidia = 16.0 ± 1.7 x 5.9 ± 0.6 µm; L/B = 2.7], unicellular, hyaline, becoming light brown and 1-2-septate with age.

HOLOTYPE. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 3 Road, Baldwin orchard, on small dead branches of *Populus nigra*, Pennycook, 17 Dec 1981 (GJS 81-393 = PDD 45438 = PDDCC 8003 = ATCC 58191).

HABITAT. On wood of *Populus nigra*, *Malus* X *domestica* Borkhausen, and *Actinidia deliciosa*, and fruit of *A. deliciosa*.

ADDITIONAL SPECIMENS EXAMINED. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 3 Road, Baldwin orchard, on *P. nigra*, Samuels & Pennycook, 21 Jun 1982 (PDD 44388); Te Puke, No. 2 Road, Reid orchard, on *P. nigra*, Samuels & Pennycook, 15 Jul 1981 (PDD 45404 = PDDCC 8002 = ATCC 58190); Te Puke, Griffin orchard, on prunings of *Actinidia deliciosa*, Samuels, 2 Jul 1975 (PDD 35365; anamorph only). *Hawkes Bay*: Havelock North, Mangateretere Road, Lowe orchard, on twigs of *Malus* X *domestica*, Samuels, 27 Jul 1975 (PDD 45405 = ATCC 58189; anamorph only).

ADDITIONAL CULTURES EXAMINED. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 1 Road, DSIR Research Orchard, from lesions on ripe fruit of *A. deliciosa*, Pennycook, 6 Oct 1982 (PDD 46738 = PDDCC 7923, 7924, 7925, 7933).

3. **Fusicoccum luteum** Pennycook & Samuels, sp. nov. [Figs 2.12-2.13]

Fusicocco aesculi similis sed conidiis latioribus (20-24 x 6-7 µm) et colonia agarum lutescente.
Holotypus: PDD 45400.

Fructifications not known from nature.

CHARACTERISTICS IN CULTURE. Colonies grown 3 weeks at 20°C in diffuse daylight; on PDA, OA, and CDA, aerial mycelium grey, with well developed, hyphal, rope-like strands, mostly at the periphery, reaching lid of Petri dish; on CDA, aerial mycelium generally lacking at the center; on PrA, translucent with sparse aerial mycelium. Yellow pigment (soluble in polar solvents) diffusing into the medium below 3-day-old colonies grown in darkness or diffuse daylight; pigment pronounced on PDA, CMD, and CDA, less conspicuous on PrA; on PDA, pigment below 4-6-day-old colonies changing from yellow to dull violaceous; on all media, pigment increasingly obscured in colonies older than 7 days, particularly those grown in light. Pycnidia forming within 9 days at 20°C with 12 h darkness: 12 h near-ultraviolet and visible illumination. On PrA, pycnidia numerous, uniformly distributed, most immersed; superficial pycnidia solitary, non-aggregated, pyriform with a conical papilla and a globose base, 280-435 μm high x 220-280 μm wide, clothed in flexuous, olivaceous to cinereous hyphae; conidia oozing within 9 days. On PDA, pycnidia numerous, scattered, superficial, tending to form an almost continuous layer with blackening of the colony in some areas; solitary or aggregated, but aggregates not globose; individual pycnidia globose, non-papillate, 250-400 μm diam., clothed in flexuous, cinereous to olivaceous hyphae; conidia oozing from most pycnidia within 9 days, and germinating in high numbers in the conidial mass. Conidia ellipsoidal to fusiform, with a flat or round base, (14-)20-24(-32) x (5-)6-7(-9) μm [mean ± standard deviation of 582 conidia = 21.7 ± 2.1 x 6.7 ± 0.6 μm; L/B = 3.2], unicellular, hyaline, remaining hyaline and becoming 1-2-septate with age.

HOLOTYPE. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 1 Road, DSIR Research Orchard, isolated from lesion on ripe fruit of *Actinidia deliciosa*, Pennycook, 6 Oct 1982 (SRP 1056-5 = GJS 83-10 = PDD 45400 = PDDCC 8004 = ATCC 58193).

HABITAT. Isolated from fruits of *Actinidia deliciosa*, *Malus* X *domestica*, and *Pyrus communis* Linnaeus.

ADDITIONAL CULTURES EXAMINED. NEW ZEALAND: *Bay of Plenty*: Te Puke, No. 1 Road, DSIR Research Orchard, from lesions on ripe fruit of *A. deliciosa*, Pennycook, 6 Oct 1982 (PDD 45401 = PDDCC 7926, 7927, 8005). *Auckland*: Kumeu, DSIR Research Orchard, from lesions on ripe fruit of *Malus* X *domestica*, Pennycook, 7 Oct 1982 (PDD 45402 = PDDCC 7928, 8006, 8008, 8010; PDD 45403 = PDDCC 8007 = ATCC 58194); Mt Albert, from lenticel spots on fruit of *Pyrus communis*, Rees-George, 2 Feb 1984 (PDD 46792 = PDDCC 8834).

ACKNOWLEDGMENTS

K.A. Hoksbergen and M.A. Manning (Plant Diseases Division, DSIR) for fruit rot isolations; B.F. O'Flaherty (NZ Fruitgrowers' Federation bursar) for benzimidazole sensitivity testing; J.R. Dale and C.M. Triggs (Applied Mathematics Division, DSIR) for statistical analyses; G. Kuschel (Entomology Division, DSIR) for checking the Latin diagnoses. We appreciate the loan of Saccardo's specimen of *F. aesculi* (PAD).

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MYCOTAXON

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DISCHLORIDIUM ROSEUM

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The monotypic anamorph genus Hyalocylindrophora was introduced by Crane and Dumont (1978) with H. venezuelensis Crane & Dumont as holotype. The genus was depicted by Carmichael et al. (1980) as forming Stilbella-like synnemata, which led the senior author to examine authentic material of H. venezuelensis in the course of his studies of synnematous Hyphomycetes. The species was recognized by the junior author as identical with Acremonium roseum Petch, which had earlier been excluded from Acremonium without a final taxonomic decision (Gams 1971).

Bhat and Sutton (1985) recently reduced Hyalocylindrophora to synonymy with Dischloridium B. Sutton. In spite of a considerable difference in pigmentation, we accept this synonymy, and the transfer A. roseum to Dischloridium. The species is redescribed and illustrated below.

Dischloridium roseum (Petch) Seifert & W. Gams, comb. nov. Figs. 1—7.

=Acremonium roseum Petch, Ann. R. bot. Gard. Peradeniya 7: 317. 1922 (basionym).
=Hyalocylindrophora venezuelensis Crane & Dumont, Can. J. Bot. 56: 2616. 1978 = Dischloridium venezuelense (Crane & Dumont) D.J. Bhat & B. Sutton, Trans. Br. mycol. Soc. 84: 725. 1985.

Colonies white, hirsute, floccose, lanose or stellate, forming circular, ellipsoidal or linear patches of conidiophores 250-6000 µm diam. Conidiophores arranged in caespitose tufts, sometimes solitary, hyaline, sometimes becoming slightly brown at the base, cylindrical, appearing capitate when viewed through a dissecting microscope because of the formation of terminal spore masses, 125–500 µm tall, 8–12 um wide, 2–11 septate, wall to 1–2 µm thick at the base, becoming thinner towards the apex. *Conidiogenous cells* phialidic, integrated, terminal, cylindrical, often proliferating percurrently 1–4 times, hyaline, 55–110 µm long, 8–12 µm wide, walls slightly thickened, periclinal thickening slight or to 2 µm thick at the apex, with slightly flaring terminal or secondarily intercalary collarettes. *Conidia* ellipsoidal, oblong ellipsoidal or ovate, sometimes with a slightly truncate base, aseptate, hyaline, 28–48 x 16–23 µm, wall 1–2 µm thick, to 3 µm thick at the poles, accumulating in hyaline balls of mucus at tips of the phialides.

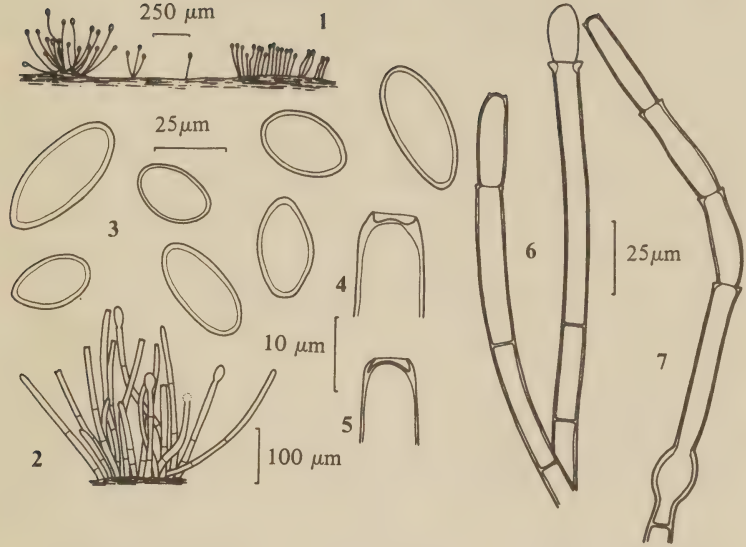
HABITAT: Decorticated decaying wood.

MATERIAL EXAMINED: *Acremonium roseum*, holotype, no. 5523, Peradeniya, Jan. 1918, herb. Petch (K, isotype IMI 103644). *Hyalocylindrophora venezuelensis*, isotype, on unidentified wood, leg. K.P. Dumont, G.J. Samuels and L. Borjas, 30 km N. of San Cristobal, on San Cristobal-La Grita road, Edo, Tachira, Venezuela, 28 July 1971 (ILLS 36940).

Dischloridium roseum cannot be regarded a synnematous species, even though the illustration in Carmichael et al. (1980) depicts *Stilbella*-like synnemata. The conidiophores are normally not fasciculate and remain distinct from neighbouring conidiophores throughout their length. Fascicles of two or three closely adpressed conidiophores, as illustrated by Crane and Dumont (1978, fig. 9), have not been observed on the specimens we examined and are probably an uncommon feature.

The type species of *Dischloridium*, *D. laeense* (Mats.) B. Sutton, is distinguished from *D. roseum* by its brown conidiophores and smaller conidia (Bhat & Sutton, 1985).

We are grateful to the curators of ILLS, IMI and K for the loan of material in their care. Prof. Dr. David L. Hawksworth kindly reviewed the manuscript. The senior author acknowledges with thanks a Postgraduate Scholarship from the Natural Sciences and Engineering Research Council of Canada.



Figs. 1–7. Dischloridium roseum, camera lucida drawings. 1. Habit. 2. Habit of single colony. 3. Conidia. 4–5. Details of phialide apices. 6–7. Conidiophores. (1–4, 6 from ILLS 36940; 5,7 from holotype of Acremonium roseum.)

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CONTRIBUTION TO THE LICHEN FLORA OF URUGUAY. XXI.
Additions to the Rio de la Plata lichen flora.

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SUMMARY: Twenty one species which belong to the Rio de la Plata lichen flora are listed. *Lecidea icterica*, *Xanthoparmelia congensis* and *X. hypopsila* are recorded from maritime habitats for the first time. *Cladia aggregata*, *Cladonia didyma* and *Cl. furcata* are added to the known maritime lichen flora of Uruguay.

This is the fourth contribution dealing with the lichen flora of the coasts of the Atlantic Ocean and the Rio de la Plata within the limits of the Marsden Square 413 (30°-40°S and 50°-60°W). In this manner the long-term research named " Plan de Ciencias del Mar" (URU/82/009, PNUD/UNESCO) carried out by the Facultad de Humanidades y Ciencias , Montevideo, Uruguay is continued.

In the present paper additional gatherings from the Rio de la Plata coast (RPC) in Montevideo Department are listed. Collections made in four localities of the coast of Canelones Department are also included.

The number of species found in the different collections sites visited by the author is rather low. The increasing urbanization along the Rio de la Plata coast in both Departments can be considered one of the most important factors responsible of the disappearance of habitats suitable for lichen growth. Important modifications in the landscape with touristical purposes and the increasing pollution due to different human activities developed along the Rio de la Plata coast are also factors which contribute to a progressive impoverishment of the coastal lichen flora in both Departments.

Buellia megapotamica Malme ap. Stein.

CANELONES: Balneario Cuchilla Alta, wooden fence post (8312), on trunk of *Pinus* (8415), bracts of *Pinus* strobiles (8414); Balneario Guazú Virá: trunks of *Pinus* (8421), branches of *Pinus* (8420), bracts of *Pinus* strobiles (8419). All the specimens were gathered in the aerohalin zone.

This corticolous or lignicolous species possess a very distinctive maritime distribution in Brazil and Uruguay. It is the only component of the lichen flora of the Pinus which grow in the close proximity of the sea. The collections from the Balneario Guazú Virá are the westernmost records known of this species. Its occurrence in the Department of Montevideo may be expected. Malme (1938:38) reported this species as growing on several species of trees and also on Cactaceae. In the Uruguayan collection sites visited by the author this species is at present found growing only in the Pinus planted near the shore of the Atlantic Ocean and the Rio de la Plata.

Buellia montevidensis Malme
CANELONES: Atlantida, Punta Piedras Negras, rocks on beach, hygrohalin (8186).

Caloplaca americana (Malme) Zahlbr.
MONTEVIDEO: Puerto del Buceo, rocks in a meadow, lower aerohalin (8388).

Caloplaca cinnabarina (Ach.) Zahlbr.
CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8304).

Caloplaca felipponei Zahlbr.
CANELONES: Atlantida, Los Banquitos, rocks on beach (8185), Punta Piedras Negras, rocks on beach (8187), Balneario Cuchilla Alta, rocks on beach (8317, 8318), Punta Piedras de Afilar, rocks on beach (8343, 8344).
MONTEVIDEO: Puerto del Buceo, rocks on seashore (8385, 8386, 8387), Isla del Mono, rocks on seashore, locally common (8384), Punta Carretas, rocks on seashore, locally common (6626), Punta Gorda, rocks on seashore, locally common (7492).
All the specimen were gathered in the hygrohalin zone.
In a recent paper the author (Osorio 1983:280) added Caloplaca sublobulata to the known lichen flora of Uruguay. After the issue of this paper some collections of this species published by R. Santesson (1944:21) could be revised: Skottsberg 203 and Dusén 365, both in (S). The Uruguayan sample differs in many aspects and was renamed as Caloplaca felipponei. As it is pointed out in a recent paper (Osorio, Silva and Hareau 1984:2) the type collection could not be located in (W) but four drawings based in the original collection and deposited in the private library of the author were used as reference.
This species in accordance with field observations is the main component of the "Orange Lichen Belt" in the Departments of Montevideo and Canelones.

Caloplaca festiva (Fr.)Zw. var. contigua (Mass.)Oliv.
MONTEVIDEO: RPC between Punta Shannon and Punta Carretas, rocks in a meadow, lower aerohalin (8379,8380).

Cladia aggregata (Sw.) Nyl.
CANELONES: Balneario Guazú Virá, sandy soil, Pinus plantation, aerohalin (8417).
Filson (1981) listed a large number of samples gathered in

the southernmost part of South America. Among them, many were collected in localities with evident maritime influence.

Cladonia didyma (Fée) Vain.

CANELONES: Balneario Guazú Virá, sandy soil, *Pinus* plantation, aerohalin (8416).

Cladonia furcata (Huds.) Schrad.

CANELONES: Balneario Cuchilla Alta, on soil amon grasses, not common, aerohalin (8302).

Diploschistes actinostomus (Pers.) Zahlbr.

MONTEVIDEO: Puerto del Buceo, rocks in a meadow, lower aerohalin (8390), RPC between Punta Shannon and Punta Carretas, rocks in a meadow, lower aerohalin (8377).

Diploschistes ochraceus (Anzi) Stein.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8307).

Lecanora farinacea Fée.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8308).

Lecanora fusca Müll. Arg.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8305).

Lecanora subatra Räs.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8306).

MONTEVIDEO: RPC between Punta Shannon and Punta Carretas, rocks in a meadow, aerohalin (8378).

This species is already reported from maritime habitat from the Department of Maldonado(Magnusson 1950:217, Osorio 1975: 4) under the name of *Lecanora homalea*.

Lecidea icterica (Mont.) Tayl.

CANELONES: Balneario Cuchilla Alta, on soil among grasses, scarce, aerohalin (8303).

Reported for the first time from a maritime habitat.

Lecidea montevidensis Müll. Arg.

MONTEVIDEO: Puerto del Buceo, rocks in a meadow, lower aerohalin (8391).

Lecidea oreinodes (Körb.) Web. & Hertel.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8309).

MONTEVIDEO: RPC between Punta Shannon and Punta Carretas, rocks in a meadow, lower aerohalin (8376).

Ochrolechia osorioana Vers.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8315).

Pseudoparmelia papillosa (Lynge ex Gyeln.) Hale.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8316).

Xanthoparmelia congensis (Stein.) Hale.

CANELONES: Balneario Cuchilla Alta, rocks in a meadow, ae-

rohalin (8310).
MONTEVIDEO: RPC between Punta Shannon and Punta Carretas, rocks in a meadow, lower aerohalin (8382).
Reported for the first time from a maritime habitat.

Xanthoparmelia hypopsila (Müll. Arg.) Hale.
CANELONES: Balneario Cuchilla Alta, rocks in a meadow, aerohalin (8314).
MONTEVIDEO: RPC between Punta Shannon and Punta Carretas, rocks in a meadow, aerohalin (8383).
Both collections identified by Dr. Thomas H. Nash,III.
Reported at first time from a maritime habitat.

ACKNOWLEDGMENT.

The author wants to express his gratitude to Dr. Thomas H. Nash, III for the identification of the Xanthoparmelia hypopsila and for the critical reading of the manuscript.

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A MONOGRAPH OF THE GENUS TRICHARINA AND OF A NEW, SEGREGATE GENUS, WILCOXINA (PEZIZALES)

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SUMMARY

The genus **Tricharina** Eckblad 1968 (= **Tricharia** Boudier 1885) is divided into two genera, **Tricharina** emend. and **Wilcoxina** gen. nov. Justifications for this separation are based upon apothecial struc-

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tures, mode of ascospore germination, anamorphs (**Ascorhizoctonia** vs. **Complexipes**), and ecological niches (saprobic vs. mycorrhizal). There are twelve taxa treated in **Tricharina** including four new species (**T. groenlandica**, **T. hiemalis**, **T. japonica**, and **T. striispora**), one new variety (**T. praecox** var. **intermedia**), and three new combinations (**T. ascophanoides**, **T. fibrillosa**, and **T. praecox** var. **cretea**). The genus **Wilcoxina** accommodates two new species (**W. alaskana** and **W. rehmii**), one new variety (**W. mikolae** var. **tetraspora**), and one new combination (**W. mikolae**). A key to the **Tricharina-Wilcoxina**-complex, generic descriptions for both genera, descriptions for all recognized taxa in both genera, and a list of herbarium specimens originally assigned to **Tricharia** or to **Tricharina** but not belonging to either genus are included. Four species were misassigned to **Tricharina** and are excluded: **T. bisetosa** is transferred to **Cheilymenia**, **T. mariae** is a lost species of doubtful affinity, **T. subglobispora** is a later synonym of **Trichophaea woolhopeia**, and **Tricharina velenovskyi** is a **Humaria**. Two species placed by Boudier in **Tricharia** are also excluded: **T. eichleri** is a synonym of **Trichophaeopsis bicuspis**, and **Tricharia olivascens** belongs in **Scutellinia**.

INTRODUCTION

The genus **Tricharina** Eckblad (1968) was initially recognized as **Tricharia** Boudier (1885). Boudier erected it to accommodate some small, sessile, hairy, operculate discomycetes with eguttulate ascospores. The name change was made by Eckblad because Boudier's **Tricharia** is a later homonym of a lichen generic name, **Tricharia** Fée, 1824.

Since the erection of the genus in 1885, the concept of the genus has remained essentially as delimited by Boudier. For the last century the genus has been accepted either as an independent genus (Dennis, 1960, 1968, 1978; Eckblad, 1968; Korf, 1972, 1973) or submerged in **Patella** Weber (Seaver, 1928), **Lachnea** Boud. (Svrček, 1949), or **Trichophaea** Boud. (Gamundí, 1966). The genus remained poorly understood, and the type species itself, **Tricharina gilva** (Boud. in Cooke) Eckbl., has been described with major discrepancies, summarized by van Brummelen (1983).

There has been no detailed monograph based on comparative studies. Boudier (1907) listed 20 names in **Tricharia**, but in the more recent mycological literature only 5 specific epithets have been commonly recognized: **Tricharina gilva**, **T. cretea** (Cooke) Thind & Waraitch, **T. ochroleuca** (Bres.) Eckbl., **T. praecox** (Karst.) Dennis, and **Tricharia fimbriata** (Quél.) Boud. Since 1907 additional new species have been described: **Tricharina bisetosa** Thind & Kaushal, **T. mikolae** Yang & Wilcox, **T. pallidisetosa** (Cash) Thind & Kaushal, and **T. subglobispora** Svrček.

One species, **T. mikolae**, was linked to "E-strain" mycorrhizal fungi and found to be associated with pines, forming ectendomycorrhizae (Yang & Wilcox, 1984). The mycorrhizal association erased the usual impression of **Tricharina** species as either fire-site fungi or soil saprobes, brought economic significance to **Tricharina**, and was the stimulus for this monographic study.

Tricharina is here split into two genera, **Tricharina** emend. and a new genus, **Wilcoxina** Yang & Korf. The separation is made on the basis of apothecial structures, mode of ascospore germination, and type of anamorph formed. A key to the genera, species, and varieties recognized in both genera is provided, along with lists of excluded species and of doubtful species. In addition a list of herbarium specimens which we studied, originally filed as **Tricharia** or **Tricharina**, but which are not now to be included in either genus, is also provided.

MATERIALS AND METHODS

This study is based mostly on dried herbarium specimens, supplemented with fresh materials whenever possible. More than 100 collections from 17 public herbaria and 2 personal herbaria were critically examined. Techniques for obtaining germination from ascospores of herbarium specimens have been reported earlier (Yang & Korf, 1985), and are not repeated here.

Morphological descriptions are based on observations of dried or of rehydrated specimens using the naked eye or the dissecting microscope. Microscopic studies were based on sections cut with a freezing microtome at 25 mm thickness, and on squashed tissues. Dry apothecia were first wetted with a few drops of 95% ethyl alcohol (ETOH), rehydrated in distilled water for a few minutes, and frozen on the freezing microtome stage in 50% aqueous commercial mucilage. The sections were either directly mounted in cotton-blue 706-lactic acid medium (Korf, 1952), or treated with 2% aqueous KOH, washed in distilled water, and then mounted in cotton-blue-lactic-acid solution or in lactic acid. The tissues treated with KOH must be washed with distilled water to avoid the chemical reactions with cotton-blue 706 that results in poor staining. Two other stains, Melzer's Reagent and Sudan IV in ETOH, were frequently used in testing iodine reactions and oil contents, respectively.

For scanning electron microscopy of spore ornamentations, sections were air-dried on an aluminum stud, coated with a thin film of gold-palladium, and viewed in a scanning electron microscope at 10 KV.

MORPHOLOGY AND STRUCTURE

The Apothecium

The gross morphology of the apothecia in the two genera delimited here are similar but not without differences. The apothecia of both genera are small, usually less than 10 mm broad (with a few exceptions up to 20 mm in diam), sessile, deeply cupulate and then gradually expanding to shallow cupulate and eventually discoid. Although the original definition by Boudier (1885) included only species with distinctly hairy apothecia, one new species (**Tricharina groenlandica** Dissing et al.) with elongated, brown, thick-walled cells in rows and with only a few rudimentary hairs at the margin is included. The new species has all

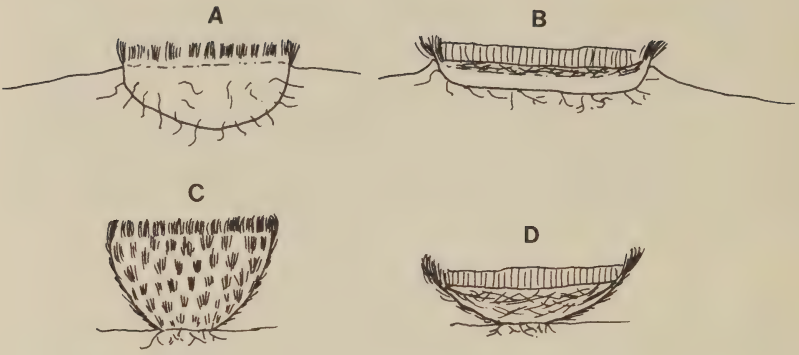


Fig. 1. Habitat sketches of apothecia of **Tricharina** and of **Wilcoxina**, all approx X 10. A. An apothecium of **Tricharina** viewed from outside, partially sunken in substrate, with only marginal fasciculate hairs. B. Section of a **Tricharina** apothecium showing hymenium and excipulum with relatively uniform thickness except near margin. C. A centrally attached apothecium of **Wilcoxina** viewed from outside, with fasciculate hairs extending from the margin to the apothecial base. D. Section of a **Wilcoxina** apothecium showing broader excipulum toward the base.

the features of a typical **Tricharina** except for its rudimentary hairs.

The apothecia of the genus **Tricharina** are broadly sessile and partially sunken in the substrate (Fig. 1A, B), and in some species, such as **T. praecox**, are formed underneath the burnt substrate and open up near the surface. On the other hand, apothecia produced by species of **Wilcoxina** are sessile and centrally attached to the substrate (Fig. 1C) even after they expand to discoid (Fig. 1D).

All species in the two genera are obviously hairy, except for one. Hairs in **Tricharina** are marginal or nearly so, but those in **Wilcoxina** are not only marginal but extend down the flanks toward the apothecial base. The margin of the apothecium is usually at the same level as the hymenium with one exception: in all three varieties of **T. praecox** the margin is usually distinctly raised over the hymenium.

The Hymenium

The hymenium in both genera is composed solely of asci and paraphyses dispersed among them. The color of the apothecium is considered an important character in grouping members of the Pyronemataceae (Korf, 1973), among which these two genera are placed. Care must be taken, however, since albino forms of colored discomycetes are not uncommon in nature. Pigmentation may also change in this group depending upon the developmental stage of the apothecium (Yang and Wilcox, 1984) and upon the intensity of light present (van Brummelen, 1983). Therefore, color of the hymenium is not emphasized in this work. The hymenial color found in the two genera is either whitish or orange-tinted, but grayish tints can be found in some collections, in what appear to be senescent apothecia.

The Hairs

There are two types of hairs in both **Tricharina** and **Wilcoxina**. The first type includes those at and near the rim of the apothecium, the **true hairs** (Fig. 2A, C, D), which are marginal and may extend slightly down the flanks in **Tricharina** and to the apothecial base in **Wilcoxina**. They are always in fascicles, from subhyaline to brownish or brown, with thin to thick walls, and are multiseptate with obtuse, blunt to pointed apices (Fig. 3A, B). They may arise from the marginal extension of the ectal excipulum, and are not rooting. The true hairs in **Wilcoxina** are in larger, dense fascicles near the margin but appear as smaller clusters towards the apothecial base, eventually with only a few hairs per fascicle at the base (Fig. 4A, B). Hairs at the margin are also often mixed with some less differentiated hairs or elongated marginal cells which have the same color, structure, and wall thickness as true hairs but are much shorter, often blunt, and less differentiated. We consider these rudimentary true hairs, and they are usually found at the inner margin adjoining the hymenium.

The true hairs of **Tricharina** and of **Wilcoxina** differ structurally in two aspects: (1) the hairs of **Tricharina** have a broad basal cell (Fig. 2A, B) connected to the cells of the ectal excipulum, while in **Wilcoxina** the hair base is narrower than the mid-point of the hair and becomes frequently septate (Figs. 3C, D; 4A, B); (2) hairs of **Wilcoxina** contain globose inclusions of the same color as the hair walls, the inclusions being within the cells and often attached to the inside of the hair walls, while such inclusions are rarely found in the hairs of **Tricharina**.

The second type of hair, the **basal hair** (Fig. 2B), is found in both genera and is restricted to the base of the apothecium. Such basal hairs arise singly from the outermost layer of the ectal excipulum, rather than in fascicles, are thick-walled, flexuous, with an inflated, almost globose basal cell, and often branched and hypha-like. The basal hairs are usually light-colored, yellowish to brownish, and extend into the substrate. These are considered to be modified anchoring hyphae instead of true hairs.

The Excipulum

The excipulum in **Tricharina** is two-layered (Fig. 2). The transition between the two layers is usually gradual, but may be clearly differentiated. Thickness of the excipulum is relatively uniform in an apothecium except near the margin (Figs. 1B; 2A-G).

A two-layered excipulum is also found near the margin in the apothecium of **Wilcoxina** (Fig. 4A,B), but the ectal layer gradually becomes mixed with some small diameter hyphae from the ental layer toward the apothecial base. The excipulum here is thin near the margin but gradually becomes thicker towards the base (Figs. 1D; 4A, B) and is usually much thicker than the hymenium.

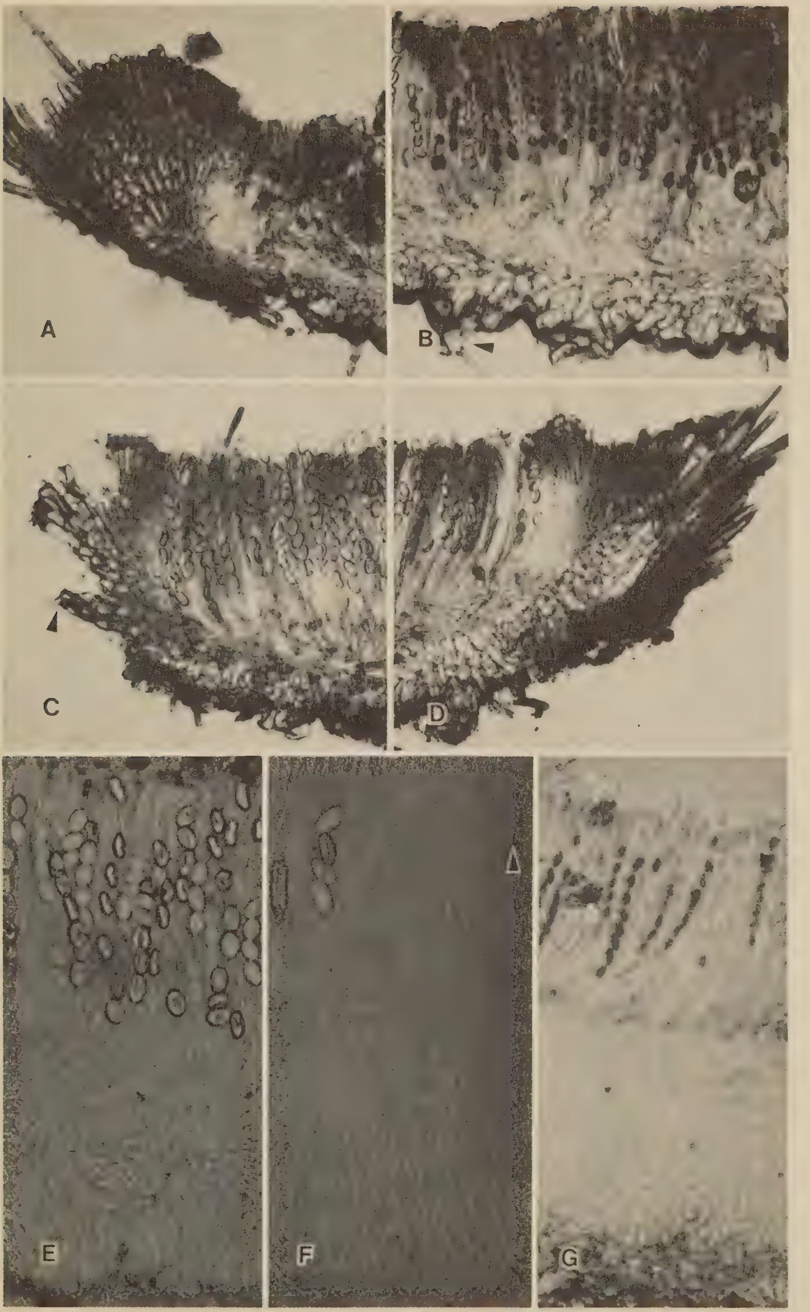
The ental excipulum differs markedly in the two genera. In **Tricharina** (Fig. 2B, E-G) it can be thin (20-40 μm, barely distinguishable from the subhymenium) to moderately thick (over 200 µm), and composed of textura intricata, the hyphae narrow to slightly inflated and always hyaline. In **Wilcoxina**, however, the ental excipulum is thick, and may be as thick as 500–700 µm, composed of small-diameter hyphae, hyaline to pale brown, which may be slightly enlarged toward the apothecial base. A few hyphae in the ental layer of **W. mikolae** (Yang & Wilcox) Yang & Korf var. **mikolae** and in var. **tetraspora** Yang & Korf differentiate into vessel-like, tubular elements with thick, refractive walls, up to 200 µm long, horizontally dispersed in the upper ental layer. The function of these elements is not clear at present. Similar structures were not observed in either **W. rehmii** Yang & Korf or in **W. alaskana** Kempton, Yang, & Korf.

The ectal excipulum of all **Tricharina** spp. is of textura globulosa to angularis (Fig. 2B, E–G), composed of inflated cells with hyaline to pale yellow, relatively thin walls 0.5–1.0 mm thick. Because of their large cell volume and thin walls, these cells often collapse in dried herbarium specimens and are hard to revive in water or 2% aqueous KOH. The ectal excipulum of **T. hiemalis** Yang & Korf (Fig. 2F) can also be divided into two zones. The outer zone is composed of 1–3 layers of brownish, thick-walled, inflated, nearly globose cells which often collapse in dried specimens. The inner zone is composed of 3–5 layers of thin-walled, hyaline, isodiametric cells, more easily reviving in the rehydration process. The ectal excipulum of all **Wilcoxina** spp. is of textura angularis and composed of 3–7 layers of brownish, thick-walled, radially elongated cells which are arranged in chains or in rows (Fig. 4A, B).

The Asci and Paraphyses

Asci in both genera are apically operculate, cylindrical with a narrowing base, non-amyloid, and 8-spored. Occasionally a few 4–6-spored asci were observed in otherwise 8-spored hymenia. The reasons for the irregularities are (1) abortion of young ascospores, the remaining ascospores being uninucleate and the aborting spores

Fig. 2. Apothecial structures of **Tricharina** spp. A. Section through the margin of an apothecium of **T. gilva**; note marginal hairs and less differentiated, elongated cells at the inner margin, X 150 (GR82-123, C). B. Median section through an apothecium of **T. gilva**; note relatively uniform thickness of the two-layered excipulum; basal hair or anchoring hypha (arrow) extending into substrate from outermost excipular layer, X 150 (GR82-123, C). C. Apothecial structure near the margin of an apothecium of **T. groenlandica**; note elongated cells at margin and rudimentary hair (arrow) near the margin; the two-layered excipulum is distinguishable, x 150 (holotype). D. Apothecial structure near the margin of an apothecium of **T. ochroleuca**; note marginal hairs and radially elongated excipular cells, X 150 (neotype). E. Median section of an apothecium of **T. ochroleuca**; note 8-spored asci, two-layered excipulum, and excipular structure, X 250 (CUP 61632). F. Median section of an apothecium of **T. hiemalis**; note only a few spores in section, immature spores in an ascus (arrow), and two-layered excipulum, with several outermost cell layers of the excipulum collapsed, X 250 (CUP 61631). G. Median section of an apothecium of **T. praecox** var. **cretea**; note 8-spored asci, thin ental excipulum, thick ectal excipulum and cell arrangement, X 150 (Kristiansen, 1982, S).


A
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sometimes being observed in asci with maturing spores, or (2) abnormal inclusion of two nuclei in ascospores, the resultant ascospore being larger, with no trace of aborting spores. One variety of **Wilcoxina mikolae** is recognized with consistently 2-4-6-spored asci, yet with smaller ascospores than the 8-spored variety.

The arrangement of ascospores within each ascus is usally uniseriate, but both uniseriate and subbiseriate asci were found in **Tricharina ascophanoides** (Boud.) Yang & Korf. The subbiseriate asci have 4 or 6 spores biseriate with the rest of the spores uniseriate. Subbiseriate asci were also observed by Boudier in this species, as shown in his plate (Boudier, 1904-1911: pl. 351), and this feature makes this fungus readily separable from other Tricharinas.

One of the easiest ways to distinguish the two genera lies in the proportion of the mature ascus occupied by ascospores, as well as ascus length. In **Wilcoxina** the asci may be 200 µm long or longer, and the ascospores are usually lined up in the upper half of the ascus. In **Tricharina** the asci are usually much shorter than 200 µm, and the 8 ascospores often almost completely fill the ascus.

Paraphyses in both genera are usually slender, multiseptate, equal or slightly enlarged near the apex, and if branched, do so only near the base. The species with colored hymenia have carotenoid particles uniformly distributed within the paraphyses, but the distribution is not clear in old, dried specimens.

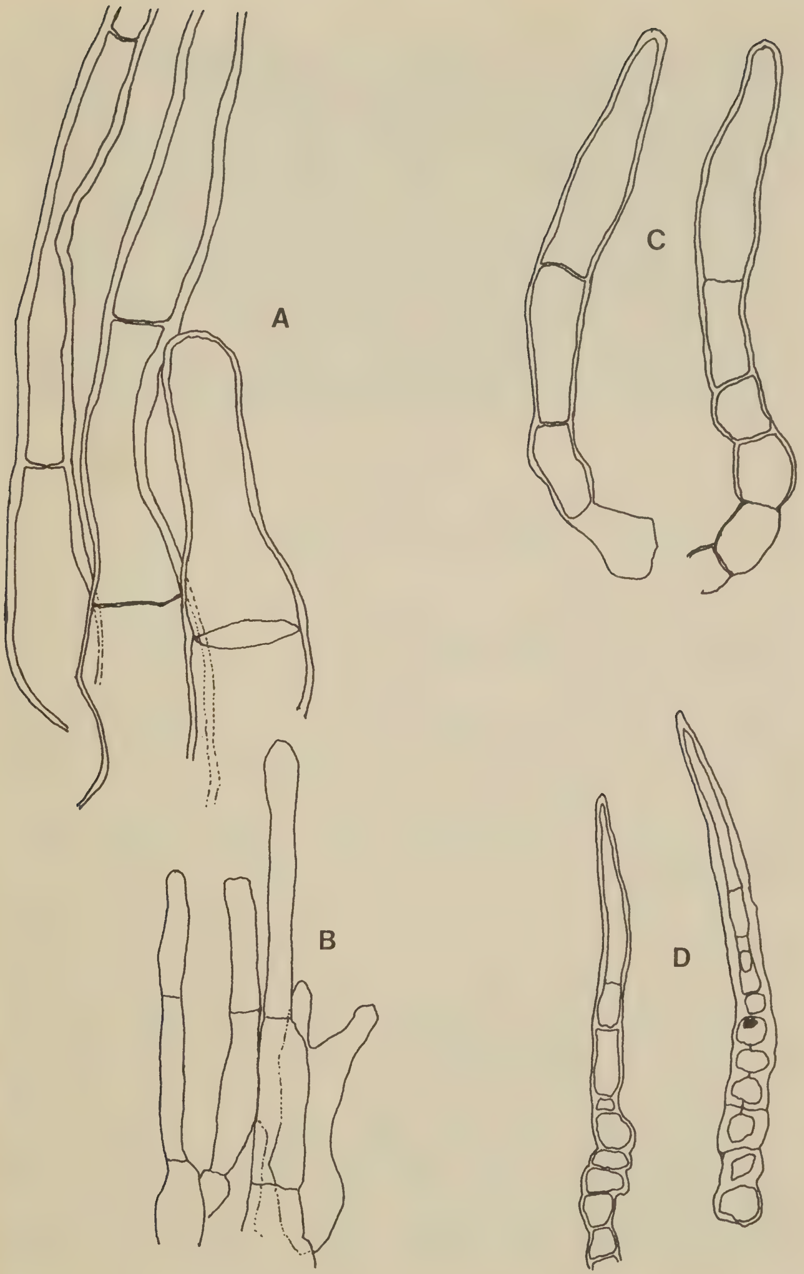
The Ascospores

The shape of the ascospores in the two genera studied is ellipsoid, broadly ellipsoid, or subfusoid to trapezoidal (Figs. 5, 6). No globose spores have been found in either genus. The spore shape is consistent in each taxon, providing a reliable character to separate taxa.

Ascospore development can be divided into three stages: (1) young, immature spores - not collapsing, hyaline, the cytoplasm staining blue in cotton-blue, and usually larger than postmature spores (Fig. 6C, D, H, J, K); (2) mature spores - not collapsing, hyaline or yellowish when observed in lactic acid, cytoplasm not staining in cotton-blue; (3) postmature spores - often collapsing or collapsed, hyaline or refractive-yellow when viewed in lactic acid or cotton-blue lactic acid, cytoplasm not staining in cotton blue, and smaller in size than maturing or just-matured spores (Fig. 6B-D, J, K). Mature and postmature spores usually do not have deBary bubbles but have a thin, cyanophilic sheath discernible only under an oil immersion lens when stained with cotton blue. The cyanophilic sheath is not as strongly stained as in other genera, such as **Cheilymenia** Boud. and **Pseudombrophila** Boud.

The young, immature spores and those just mature have the largest spore measurements. As the spore continues to mature, the spore size decreases slightly. Spore measurements of postmature spores can be 2-3 µm shorter and 0.5-2.0 µm narrower than those of younger spores. Because the measurements of postmature spores are the most stable, spore sizes given in this paper are those of

Fig. 3. Hairs of **Tricharina** and of **Wilcoxina**. A. **Tricharina gilva**, X 1000 (holotype). B. **T. praecox** var. **praecox**, X 500 (holotype). C. **Wilcoxina mikolae**, X 1000 (CUP 60689). D. **W. rehmii**, X 1000 (TRH 72-9).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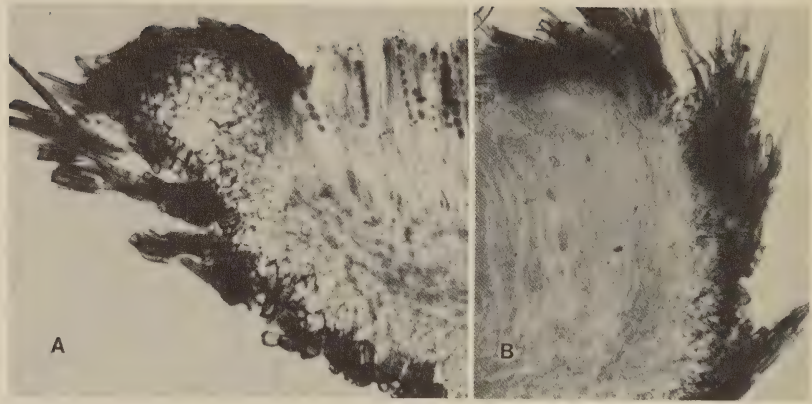


Fig. 4. Sections of apothecia of **Wilcoxina rehmii**, X 135. A. Margin of mature apothecium; note 8-spored asci, hairs frequently septate near base, in fascicles (Bresadola, Julio 1883, S); B. Young apothecium; note hairs with pointed apices in fascicles at margin and along flanks toward apothecial base (CUP-MM 1421).

mature and overmature ones, recognizable by their yellow refractive color when viewed in lactic acid. When comparisons of our measurements with those reported by others are made, this point should be kept in mind.

The yellow refractive color of ascospores is a good indicator of spore maturity, but the yellow color can be removed by brief treatment in KOH solutions. The cytoplasm of such treated spores will stain in cotton blue, in contrast to untreated spores. Germinating ascospores and spores in sections mounted in lactic acid for a long period of time (1 year or longer) also lose the yellow refractive color. Thus care must be taken when judging spore maturity in selecting mounting media and in using previously prepared slides.

The ascospores in both genera are smooth in most taxa, exceptions being three taxa in **Tricharina**: T. **praecox** var. **praecox**, T. **praecox** var. **cretea** (Cke.) Yang & Korf, and T. **striispora** Rifai, Yang & Korf. In these taxa the ascospores are ornamented with cyanophilic dots (Fig. 6A, K), which are usually less than 0.5 µm in diam and only visible under the light microscope when stained with cotton blue and viewed under oil immersion. The ornamentations are often more conspicuous on postmature and collapsed spores than on mature ones. They are randomly distributed in the two varieties of **Tricharina praecox**, but are in longitudinal stripes along the spore axis in T. **striispora**.

All ascospores are eguttulate, as originally defined for **Tricharia** by Boudier (1885, 1907), but small granules are often found internally in many species in both genera. The granules are not stained with Sudan IV in ETOH, and are probably glycogen. The granules exist as small particles, usually less than 0.5 µm diam and often much smaller, and are easily overlooked because mature

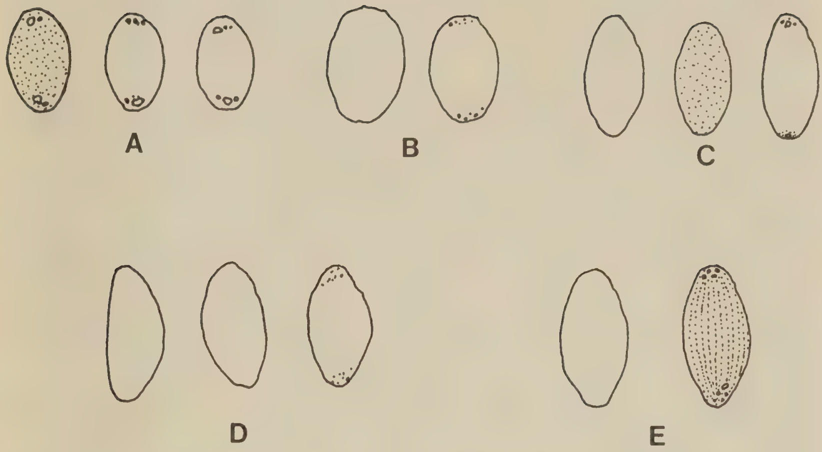


Fig. 5. Ascospore shapes and ornamentations in species of **Tricharina**, X 1000. A. Ellipsoidal, with length to breadth ratios near 1.5 in **Tricharina praecox** var. **praecox**; note polar granules and random arrangements of spore markings (holotype). B. Broadly ellipsoidal with almost truncate ends in **T. gilva**; note polar granules, absence of ornamentation (TRH 79-108). C. Subfusoid or oval, with length to breadth ratios close to 2.0 in **T. praecox** var. **cretea**; note polar granules and random surface ornamentation (holotype). D. Trapezoidal, occasionally with one side flattened, in **T. japonica**; note polar granules, absence of ornamentation (holotype). E. Ellipsoidal, ornamented with longitudinal stripes of cyanophilic dots, in **T. striispora**; note polar granules (holotype).

spores have a yellow refractive layer. The fine granules often collect near the two poles. The granules can be observed in mature, yellow-walled spores with or without an oil immersion lens, or by removing the yellow wall material in KOH and then staining the cytoplasm with cotton-blue.

Ascospore Germination and Anamorphs

Fresh ascospores of both genera are apparently ready to germinate without any delay, although only a few collections have been tried with fresh ascospores. Spores from dried herbarium specimens up to 10 years old or even older germinate after being revived in water following a rehydration protocol (Yang & Korf, 1985).

The process of ascospore germination in the two genera differs. Spores of **Tricharina** often germinate in 24-48 h after rehydration, while spores of **Wilcoxina** take several da to 2 wk. The germ tubes of **Tricharina** are cylindrical, fast-elongating, and remain unbranched for the first 2-3 da, but those of **Wilcoxina** form chlamydospore chains or are cylindrical with constrictions at the septa, slow-growing, and often branched. The germinating ascospores of **Wilcoxina** often have a median, internal septum, but that has never been observed in spores of **Tricharina**. More details on spore germination processes are described elsewhere (Yang & Korf, 1985).

The anamorphs obtained belong to two genera, **Ascorhizoctonia** Yang & Korf and **Complexipes** Walker emend. (Yang & Korf, 1985). **Ascorhizoctonia** is characterized by its fast-growing mycelium covering 90-mm petri plates at room temperature in 5-7 da, mycelium being hyaline, or brownish to brown, and producing "sporodochia" or swollen, chlamydospore-like cell aggregates. **Complexipes** has mycelium slow to medium fast-growing on PDA and produces brown, verrucose hyphae and, sometimes, characteristic chlamydospores. Species of **Tricharina** yield **Ascorhizoctonia** anamorphs; members of **Wilcoxina** produce **Complexipes**.

HABITAT AND ECOLOGY

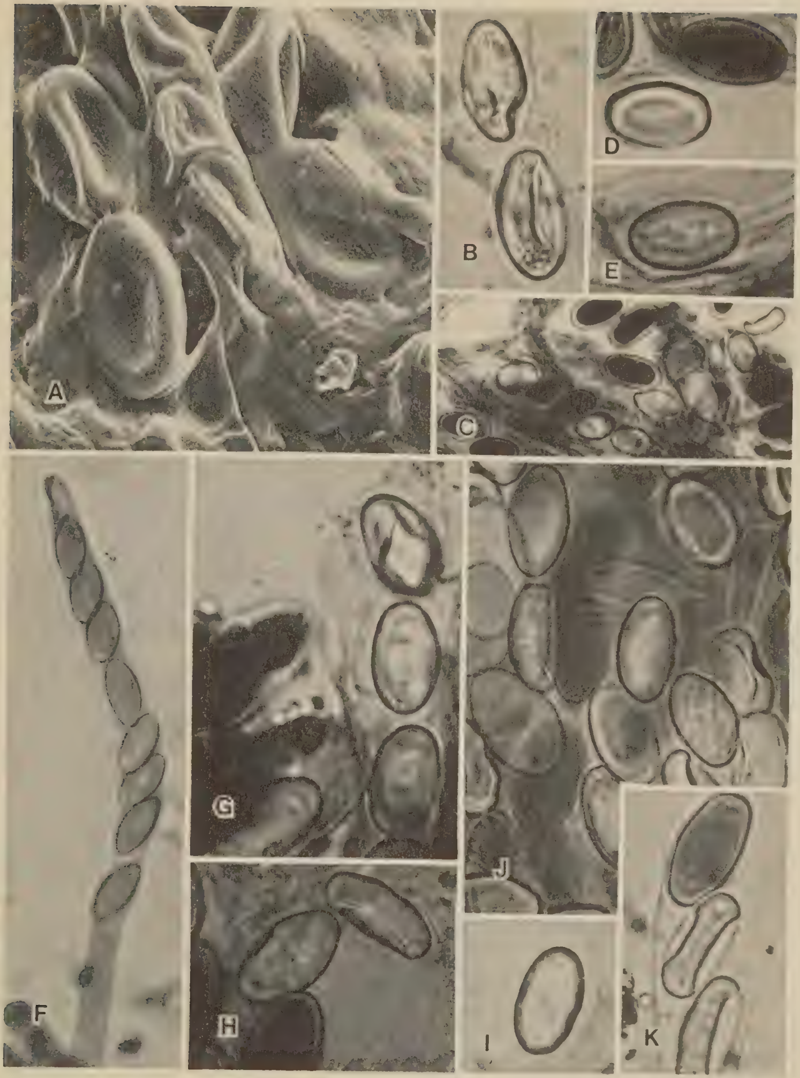
Although members of these two genera are morphologically and structurally similar in many aspects, their ecological niches seem totally different. Species of **Tricharina** are found in soil, on burn sites, occasionally on plaster walls in a burnt house, or on decayed organic materials. It is very likely that they are all saprobic. On the other hand, three of the four taxa of **Wilcoxina** recognized here, the two varieties of **W. mikolae** and **W. rehmii**, are mycorrhizal in association with pinaceous conifers (Yang & Wilcox, 1984 and unpublished results; Yang, unpublished results). **W. alaskana** was collected from decayed, mossy logs, but the type collection was apparently too old to yield a culture, and mycorrhizal synthesis experiments could not be undertaken. The fungus is still very possibly mycorrhizal, as is the case in putative mycorrhizal Basidiomycetes which are often found to fruit on rotten logs (Krupp and Trappe, 1982).

TAXONOMIC CONSIDERATIONS

The genus **Tricharina** Eckblad (= **Tricharia** Boud.) was clearly defined by Boudier (1885, 1907) on the basis of apothecial structures. But there are two groups within the genus, readily separable on minor morphological features, on mode of ascospore germination, on type of anamorph produced, and on mode of nutrition (Yang and Korf, 1985). Thus a new genus, **Wilcoxina**, including four taxa, is separated here from **Tricharina**.

Twelve taxa are recognized in **Tricharina** sensu stricto, of which seven are known to produce an anamorph assignable to **Ascorhizoctonia** (Yang and Korf, 1985). The lectotype species of

Fig. 6. Photomicrographs of ascospores of **Tricharina** spp. A. SEM of **T. praecox** var. **cretea**; note ornamentation on spore surface, X 1980 (Kristiansen, 1982, S). B. Two mature spores of **T. ascophanoides**; note strong polar granules, X 1000 (holotype). C. **T. gilva** mounted in lactic acid-cotton blue 706; note only immature spores take up blue stain and are larger than mature spores, X 400 (holotype). D. Immature (above) and mature spore of **T. gilva**; note inconspicuous polar granules, X 1000 (S73.050, C). E. **T. gilva**, mature, with polar granules, X 1000



(GR82.123, C). F. Eight-spored ascus in **T. japonica**; note some spores trapezoidal, X 400 (holotype). G. **T. groenlandica**, mature; note strong polar granules, X 1000 (holotype). H. **T. ochroleuca**, mature, X 1000 (S-Bresadola, no date). I. **T. ochroleuca**, mature, X 1000 (neotype). J. **T. praecox** var. **praecox**; note polar granules, spore ornamentation not stained, X 1000 (lectotype). K. **T. praecox** var. **cretea**, note polar granulations and ornamentations stained with lactic acid-cotton blue 706 on both mature and immature spores, X 1000 (Kristiansen, 1982, S).

Tricharina is **T. gilva**, selected by Clements and Shear (1931) as the type species for the replaced generic synonym, **Trícharia** Boud. Although both **Peziza gilva** Boud. in Cooke and **P. fimbriata** Quél. in Cooke were originally described and illustrated in separate figures on the same plate in Cooke's Mycographia in 1879, the name **P. fimbriata** and combinations based on it have not been as widely used as **P. gilva** and the combinations based on that name, and Quélet's name is here reduced to synonymy with Boudier's. Cooke (1879) described the two species as very similar except for **P. fimbriata** having hairs restricted to the margin, and larger spores. Our measurements indicate that spores are all in the same range in both type specimens. Hair length and number of septa per hair are greater in the type of **P. fimbriata** than those in the type of **P. gilva**, but whether these differences result from environmental or genetic differences remains to be answered.

Tricharina gilva has been described with a wide variation in structure, measurements, and even habitats. A summary concerning these discrepancies was given by van Brummelen (1983). His concept of the species (and perhaps that of other authors) was very broad, encompassing also material we segregate here as **Wilcoxina mikolae** var. **mikolae**.

Boudier described **T. gilva** based upon a specimen collected in Montmorency, France, on moist ground according to Cooke (1879), but on humus or on manured garden soils according to Boudier (1904-1911). Seaver (1928) was probably the first to describe **T. gilva** from an old burnt place overrun with mosses. Later, fire-site Tricharinas were often (mostly erroneously) identified as **T. gilva** (Dennis, 1960, 1968, 1978; Eckblad, 1968; Petersen, 1970, 1971, 1975; van Brummelen, 1983; and labels of many herbarium specimens examined and listed below).

Two species placed in **Tricharina** were originally described from burn sites, **T. praecox** and **T. cretea**. Karsten (1869) described **T. praecox** from two specimens collected at two sites in Tammela, Finland. Cooke (1877) illustrated **T. cretea** from a plaster wall and ceiling of a house in Great Britain in which the roof had been burnt (Cooke, 1879). All three collections are similar except for hymenial color and spores shape. Spores of **T. cretea** are more fusoid, those of **T. praecox** ellipsoid. The anamorphs derived from specimens later identified with one or the other of the two species show similar morphology, but some variation. The two discomycetes are considered here to represent varieties, **T. praecox** var. **praecox** and **T. praecox** var. **cretea**.

A North American specimen collected from an old burnt place overrun with mosses and identified by Seaver as **Patella gilva** (Boud.) Seav. was examined and is considered conspecific with Boudier's type. On the other hand, several specimens collected from burn sites in Canada by K. N. Egger are closer to **T. praecox**, but lack the conspicuous, cyanophilic ornamentations on the spore surface found in both **T. praecox** var. **praecox** and var. **cretea**. Anamorphs isolated by Egger also showed similar cultural morphology to those of the two varieties of **T. praecox**, but had an intermediate growth rate (Yang and Korf, 1985). A new variety is created for this North American burn-site taxon, **T. praecox** var. **intermedia** Egger, Yang & Korf. Ascospores of this variety are similar in shape to those of the type variety, but lack cyanophilic dots as ornamentation.

Tricharina ochroleuca is recognized as an independent species, although it is structurally close to **T. gilva**. The ellipsoid spores with more rounded ends are clearly different from the broadly ellipsoid spores with often almost truncate ends in **T. gilva**. Anamorphs of the two species are also easily separable (Yang and Korf, 1985).

Four new species are recognized, **T. groenlandica**, **T. hiemalis** Yang & Korf, **T. japonica** Yang & Korf, and **T. striispora**.

Tricharina groenlandica was recently collected by H. Dissing in Greenland. The apothecia lack conspicuous fasciculate hairs near the margin, bearing instead only some rudimentary hairs and elongated, brown, thick-walled cells arranged in rows. The rudimentary hairs arise from the outermost row of excipular cells near the margin. The anamorph derived from the specimen belongs in **Ascorhizoctonia** and is clearly different from other species of that genus.

Tricharina hiemalis is described as new from a collection of apothecia derived from a Canadian culture of **Rhizoctonia hiemalis** Saksena & Vaartaja [= **Ascorhizoctonia hiemalis** (Saksena & Vaartaja) Yang & Korf]. The apothecia were originally identified as **Trichophaea** sp. (Whitney and Parmeter, 1964; Warcup and Talbot, 1966), but the smooth, eguttulate ascospores point to its belonging in **Tricharina**. These authors may have been unduly influenced by the treatment by Kanouse (1958) in which some species we place in **Tricharina** and in **Wilcoxina** were erroneously placed in **Trichophaea**. Apothecial structures are held together very tightly, and appear waxy during sectioning, making the fungus easily recognizable. A collection from France, identified as **Tricharia praecox** by Boudier, is conspecific with **Tricharina hiemalis**, as also is one from Czechoslovakia.

The third new species, **Tricharina japonica**, was collected on soil in Japan. The fungus possesses the longest hairs, up to 800 µm long, among all Tricharinas. The ascospores in this species are also very characteristic with rounded ends and a somewhat trapezoidal shape (Fig. 6F).

The fourth new species, **T. striispora**, is from Australia and was first examined by M. A. Rifai, who provided the species epithet on a herbarium label but decided not to publish it because of the small size of the collection. The freezing microtome we employed in this study can make many sections from a small piece of an apothecium. Small collections such as this, even of only three or four apothecia, do not appear to present a problem in describing a new species. The species has a very characteristic spore ornamentation of cyanophilic longitudinal dotted stripes. No similar kind of ornamentation is found in any other species of the genus.

Two new combinations are proposed in **Tricharina**, **T. ascophanoides** and **T. fibrillosa** (Currey) Yang & Korf. Boudier (1903) described **Tricharia ascophanoides** with spores containing obvious polar granules, and later (Boudier, 1904-1911) illustrated the occasionally subbiseriate asci. This is apparently a rare, European species. Only three more collections were encountered in this study, one from France, two from Czechoslovakia. **Tricharina fibrillosa** was placed in **Cheilymenia** by Le Gal (1947) and by Dennis (1968, 1978). The eguttulate spores with yellow refractive coloring disappearing in KOH and the hairs in fascicles with blunt to obtuse apices are characteristic instead of **Tricharina**. Some species of **Cheilymenia** are characterized by rooting hairs with sharply pointed apices; these are lacking in **T. fibrillosa**. The spores of **Cheilymenia** show a yellow refractive color when mounted in lactic acid, but unlike the situation in **Tricharina**, the color in

Cheilymenia spores cannot be removed even by overnight treatment in KOH solutions as shown in trials by the senior author.

An additional species, **T. pallidisetosa** (Cash) Thind & Kaushal, is from India, and was originally sent to E. K. Cash, who described it as new in **Humaria** Fuckel (Cash, 1948). Our study of the type specimen confirms Thind and Kaushal's (1979) placement. The spores are rather large for the genus, up to 20 µm long.

Fasciculate, non-rooting hairs and eguttulate, yellow-refractive ascospores readily separate **Tricharina** from other genera, such as **Trichophaea**, **Cheilymenia**, **Scutellinia** (Cke.) Lamb., **Anthracobia** Boud., etc. **Trichophaea** may have fasciculate hairs, and at least two species, **T. abundans** (Karst.) Boud. and **T. hemisphaerioides** (Mout.) Graddon, have yellow refractive ascospores, but all Trichophaeas have guttulate spores. Many species of **Trichophaea** yield anamorphs in **Dichobotrys** Hennebert (1973) or do not germinate at all on agar media. Some species of **Cheilymenia** and all species of **Scutellinia** have single, rooting hairs with pointed apices and usually thick walls. These characters, and the different reaction of the yellow refractive spores of **Cheilymenia** to KOH noted above, are more than enough to separate **Tricharina** from these two genera. **Anthracobia** spp. have short and often-overlooked hairs, but the biguttulate ascospores without a yellow refractive color distinguish this genus easily. The four genera compared above are those most often confused with **Tricharina**. Most of the specimens examined not belonging to this genus or to **Wilcoxina** could be assigned to one of the four genera, and hiding under these generic names in herbaria are often species of **Tricharina**.

Three other genera, **Fimaria** Velen., **Pseudombrophila** Boud., and **Trichophaeopsis** Korf & Erb, may also be confused with **Tricharina**, but can be relatively easily distinguished. **Fimaria** spp. are usually found on dung, have a sterile, marginal rim on the apothecium, and lack true hairs. **Pseudombrophila** spp., probably close to **Fimaria** (Korf, 1972), have eguttulate ascospores with a deBary bubble and a relatively strongly stained cyanophilic ascospore sheath, and grow on herbaceous stems. Species of **Trichophaeopsis**, a segregate from **Trichophaea**, are characterized by having appendaged hairs, a layer one cell thick of horizontally elongated, thick-walled outer excipular cells, ascospores lacking true oil globules but possessing many small granules and having a deBary bubble.

The genus most easily confused with **Tricharina** is our new segregate genus, **Wilcoxina**. All the specimens we now identify as **Wilcoxina** were assigned to **Tricharina** originally. We believe the comparative studies detailed in this monograph justify this separation.

There are three species and one new variety in **Wilcoxina**. Although this is a rather small genus, the characteristic, highly variable, often called "E-strain", **Complexipes** chlamydospores of its anamorphs have been found worldwide (Wilcox et al., 1983). This suggests that either **Wilcoxina** has a wide distribution with only a few species, or that many species belong to the genus but only rarely produce apothecia, or that there are members of the anamorph-complex that never produce apothecia.

The type species, **W. mikolae**, was only recently described to be mycorrhizal with pinaceous conifers (Yang and Wilcox, 1984). A new variety with predominantly 4-spored asci and smaller spores, **W. mikolae** var. **tetraspora**, is also similarly mycorrhizal (Yang and Wilcox, unpublished results). Both taxa have rather short, pale brown hairs. A new species, **W. rehmii**, with dark brown hairs, is probably the most often-collected species, and a recent mycorrhizal synthesis experiment shows that it, too, is mycorrhizal with pinaceous conifers (Yang, unpublished results). **Wilcoxina rehmii** is found from near the Arctic Circle in Europe to the Canary Islands off Africa to the state of Washington, USA. Rehm (1895) and Sydow (1885) have confused it with **Tricharina gilva**, and Kanuse (1947) has confused it with **Anthracobia melaloma** (A. & S.) Boud. An anamorph belonging to the genus **Complexipes** is associated with these three taxa in **Wilcoxina**. The other new species, **W. alaskana**, was collected in Alaska and originally assigned to **T. gilva**. The long, slender, pale brown hairs and very thick excipulum make this species distinctive. Unfortunately ascospore germination was not obtained in our culture studies, probably due to the age of the specimen, and its anamorph, if any, is unknown.

KEY TO THE SPECIES OF TRICHARINA AND WILCOXINA

Note: ascospore measurements are of mature or postmature spores with cytoplasm unstained in cotton blue-lactic acid.

1 Apothecia broadly sessile, partially sunken in the substrate; hairs marginal only, in one species reduced to brown, thick-walled cells in rows; excipulum distinctly 2-layered with relatively uniform thickness; ascospores almost filling the ascus; anamorphs in **Ascorhizoctonia** TRICHARINA (2)

1' Apothecia sessile, centrally attached; hairs marginal and on the flanks down to the base; excipulum 2-layered near the margin with the ectal layer mixed with some small diameter hyphae from the ental layer toward the base; ascospores lined up in the upper half of the ascus; anamorphs in **Complexipes** (so-called "E-strain" chlamydospores) . . . . WILCOXINA (13)

2(1) Apothecia partially sunken in ash on burn sites; apothecial margin extending beyond the hymenium **T. praecox** (3)

2'(1) Apothecia usually not on burn sites; apothecial margin usually equal in height to hymenium in mature apothecia 5

3(2) Ascospores subfusoid, length to breadth ratios near 2 (2.0 + 0.1), with dot-like, cyanophilic ornamentations **T. praecox var. cretea**

3'(2) Ascospores ellipsoid, length to breadth ratios close to 1.5, with or without dot-like, cyanophilic ornamentations 4

4(3') Ascospores with dot-like, cyanophilic ornamentations **T. praecox var. praecox**

4'(3') Ascospores with cyanophilic sheath but without conspicuous, dot-like, cyanophilic ornamentations **T. praecox var. intermedia**

5(2') Ascospores with dot-like, cyanophilic ornamentations in longitudinal stripes; known only from Australia **T. striispora**

5'(2') Ascospores smooth 6

6(5') Marginal hairs reduced to brown, thick-walled cells in rows at the margin, spores with fine, polar granules . . . . **T. groenlandica**
6'(5') Marginal hairs more differentiated 7
7(6') Marginal hairs broad, obtuse, thin-walled, pale brownish, ascospores with polar granules . **T. fibrillosa**
7'(6') Marginal hairs not as above 8
8(7') Ascospores uniseriate or subbiseriate, with obvious polar granules; hairs hyaline to subhyaline, thin-walled, slender, flexuous . . **T. ascophanoides**
8'(7') Ascospores uniseriate, granules if any inconspicuous; hairs subhyaline to brownish, wall 0.5–3.0 µm thick 9
9(8') Ascospores ellipsoid, large, usually longer than 15 µm, up to 20 µm; known only from Asia 10
9'(8') Ascospores ellipsoid or broadly ellipsoid, smaller, usually less than 17 µm long 11
10(9) Ascospores ellipsoid, sometimes trapezoidal; hairs to 800 µm long; known only from Japan **T. japonica**
10'(9) Ascospores ellipsoid, not trapezoidal; hairs up to 300 µm long; known only from India **T. pallidisetosa**
11(9') Apothecial tissues holding together, appearing waxy; asci at various stages of maturity, with only a few mature and refractive yellow ascospores; ascospores with inconspicuous granules, ellipsoid . . . . . . **T. hiemalis**
11'(9') Apothecial tissues not waxy; asci maturing nearly simultaneously, most ascospores appearing refractive yellow in mature apothecia; ascospores ellipsoid or broadly ellipsoid 12
12(11') Ascospores ellipsoid, with rounded ends **T. ochroleuca**
12'(11') Ascospores broadly ellipsoid, with almosty truncate ends . . . . **T. gilva**
13(1') Hairs dark brown, with walls up to 4.0 µm thick **W. rehmii**
13'(1') Hairs pale brown, walls not as thick 14
14(13') Hairs slender and long, 300–400 µm or longer; on mossy log, known only from Alaska . . **W. alaskana**
14'(13') Hairs short, mostly less than 300 µm long; on soils, known from North America and Europe **W. mikolae** (15)
15(14') Asci 8-spored; ascospores 6.0–9.0 x 11.0–13.2 (–14.0) µm. **W. mikolae var. mikolae**
15'(14') Asci (2–) 4 (–6)-spored; ascospores smaller, mostly less than 11.0 µm long . . . . . **W. mikolae var. tetraspora**

GENERIC DESCRIPTION OF TRICHARINA EMEND.

TRICHARINA Eckblad, Nytt Mag. Bot. 15: 60. 1968, **emend.** Yang & Korf
= **Tricharia** Boudier, Bull. Soc. Mycol France 1: 104. 1885, non **Tricharia** Fée 1824 (Lichenes).

Apothecia small, deeply cupulate to discoid, broadly sessile, partially sunken in substrate; **hymenium** usually brightly colored, whitish, grayish, yellowish, orange, to wood brown; **hairs** in fascicles at the margin and sometimes partway down the flanks, subhyaline to pale brown, flexuous, with a broad base, arising from the outermost layer of the ectal excipulum, multiseptate but basal cells not frequently septate, tapering to rounded or pointed tips, occasionally less differentiated, usually with accompanying brown, thick-walled cells in rows at the margin; **excipulum** two-layered, ental layer of textura intricata and ectal layer of textura globulosa to textura angularis; **asci** cylindrical, narrowing near base, operculate, usually 8-spored, with spores filling more than half and usually nearly all of the ascus length, J-; **ascospores** broadly ellipsoid, ellipsoid, or subfusoid, uniseriate or rarely subbiseriate, smooth to finely ornamented, hyaline to yellow refractive when mature and mounted in lactic acid media, eggutulate, often with small, usually polar granules (glycogen?); **paraphyses** slender, septate, with or without carotenoid particles as inclusions, slightly enlarged towards the apex, unbranched except near the base.

LECTOTYPE: **Tricharina gilva** (Boud. in Cke.) Eckbl., selected by Clements & Shear (1931) for the replaced synonym, **Tricharia** Boud.

ANAMORPHS: **Ascorhizoctonia** Yang & Korf (1985).

HABITAT AND SUBSTRATE: terrestrial or pyrophilous, rarely found on plaster walls in a burnt situation, or on humus (reported on rotting leather).

ETYMOLOGY: from the generic name **Tricharia**, i.e., hairy.

NOTES: A new genus, **Wilcoxina**, is erected here and separated from this genus on the basis of its having narrow-based hairs with frequently septate basal portions not only marginal but extending down the flanks to the base, possession of **Complexipes** or "E-strain" anamorphs, a different excipular structure, and different mode of ascospore germination.

DESCRIPTIONS OF ACCEPTED TAXA IN TRICHARINA

TRICHARINA ASCOPHANOIDES (Boud.) Yang & Korf, **comb. nov.**
= **Tricharia ascophanoides** Boud., Bull. Soc. Mycol. France **19**: 195. 1903.
= **Lachnea ascophanoides** (Boud.) Sacc. & D. Sacc. in Sacc., Syll. Fung. **18**: 37. 1906.

ILLUSTRATIONS:
Boudier, Bull. Soc. Mycol. France **19**: tab. 8, fig. 4. 1903. (**Tricharia**)
Boudier, Icon. Mycol. **2**: pl. 351. 1908. (**Tricharia**)
This paper, Figs. 6B; 7.

Apothecia small, 2-5 mm broad, broadly sessile, initially cupulate, becoming flattened and convex; **hymenium** ochraceous white, 170-220 µm thick; **hairs** marginal, in fascicles, flexuous, relatively thin-walled, hyaline to subhyaline, easily overlooked at the margin, multiseptate, 5.5-7.5 x 150-300 µm, basal cells slightly inflated to 7.5-9.5 µm broad, apices pointed; **excipulum** two-layered, ental layer of textura intricata, 75-90 µm thick, ectal layer of textura globulosa to textura angularis, 100–130 µm thick, composed of hyaline to subhyaline, thin-walled to thick-walled, inflated cells 22.4–28.0 x 28.0–37.3 µm, up to 5–7 cell layers thick, hyaline to subhyaline anchoring hyphae extending from the outermost layer of the ectal excipulum; **asci** cylindrical, narrowing toward the base, 8-spored, 11.2–20.0 x (120–) 140–170 µm, J–; **ascospores** ellipsoid, uniseriate or subbiseriate, smooth, eguttulate but with obvious polar granules, hyaline or yellow refractive when mature and mounted in lactic acid, 9.5–11.0 x 14.6–16.1 (–16.8) µm; **paraphyses** slender, septate, hyaline, 2.0–3.0 µm wide, slightly enlarged near the apex to 4.0–5.5 µm wide.

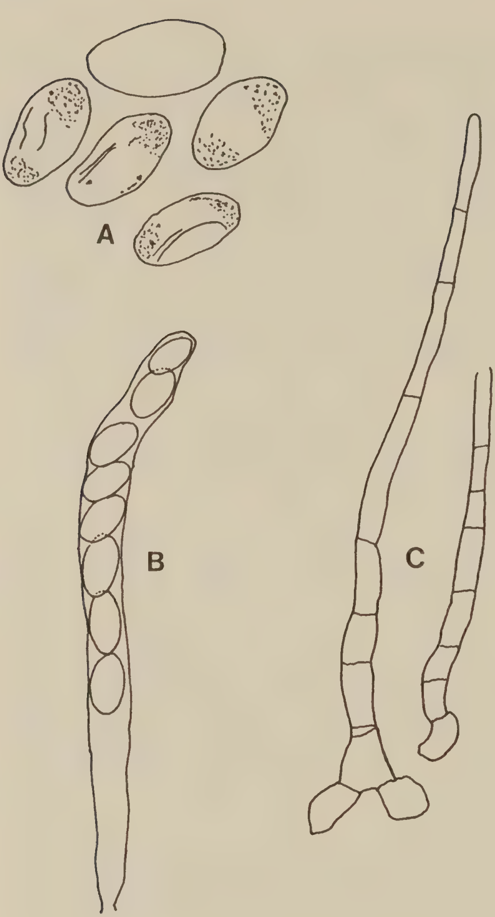


Fig. 7. **Tricharina ascophanoides** (from the holotype). A. Ascospores; note strong polar granules in mature spores, X 1000. B. Ascus with 8 ascospores, X 500. C. Marginal hairs; note thin wall, frequent septation, X 500.

HABITAT AND SUBSTRATE: on soil or decayed leather.

ETYMOLOGY: from the generic name **Ascophanus + -oides**, like.

ANAMORPH: unknown.

DISTRIBUTION: Europe, rare.

NOTES: Only a few collections were examined. The species has relatively inconspicuous hairs, but is easily recognizable by its colorless hairs, large spores with obvious polar granules, and its occasionally subbiseriate asci. The measurements given by Boudier (1904–1911), whose measurements are usually 10% too high (van Brummelen, 1969), are 4–6 µm longer and 3 µm broader than those we measured. No anamorph was obtained, although a collection dated 10.ix.1977 made by J. Moravec was tried without success.

HOLOTYPE: France, ad corium putridum, leg. M. Hetier, Arbois, Aug. 1902 (PC-Boudier).

OTHER SPECIMENS EXAMINED:

CZECHOSLOVAKIA: J. Klika, Slovakia: Brestova, 21.vii.1926 (PRM 823507); J. Moravec, on soil, Adamov near Brno, Moravia, 10.ix.1977 (CUP 61634 ex Herb. J. Moravec).

FRANCE: [collector unknown], ad corium putridum, Arbois, 7. 1901 (PC-Boudier).

TRICHARINA FIBRILLOSA (Currey) Yang & Korf, **comb. nov.**

= **Peziza fibrillosa** Currey, Trans. Linn. Soc. London **24**: 153. 1863.

= **Cheilymenia fibrillosa** (Currey) Le Gal, Ann. Sci. Nat., Bot., sér. 11, **8**: 287. 1947.

ILLUSTRATIONS:

Berkeley and Broome, Ann. Mag. Nat. Hist., ser. 3, **18**: pl. 3, fig. 17. 1866. (**Peziza**).
Cooke, Mycographia, pl. 53, fig. 207. 1876. (**Peziza**).
Dennis, Brit. Ascom., fig. 31-J. 1968. (**Cheilymenia**).
Dennis, Brit. Ascom., ed. 2, pl. VII-J. 1978. (**Cheilymenia**).
This paper, Fig. 8.

Apothecia 1-2 cm broad, cupulate, externally white fibrillose; **hymenium** orange-yellow, 200-225 µm thick; **hairs** marginal, in fascicles, thin-walled, obtuse, septate, hyaline to pale brownish, 12.0-18.6 x 100-160 µm; **excipulum** two-layered, ental layer of textura intricata, 90-112 µm thick, ectal layer 80-120 µm thick, of textura globulosa, composed of hyaline, thin-walled, inflated cells 24.3-37.3 x 37.3-41.4 µm, of 3-5 cell layers, hyaline anchoring hyphae extending from inflated cells of the outermost layer of the ectal excipulum; **asci** cylindrical, narrowing towards the base, 8-spored, 9.0-11.0 x 190-210 µm, J-; **ascospores** ellipsoid, smooth, eguttulate with occasional polar granules, uniseriate, hyaline or yellow refractive when mature and mounted in lactic acid, 8.0-9.0 x 13.9-15.8 µm; **paraphyses** slender, enlarged to 5.0-6.0 µm near apex, containing carotenoid particles.

HABITAT AND SUBSTRATE: on soil.

ETYMOLOGY: from the fibrillose appearance of the apothecium.

ANAMORPH: unknown.

DISTRIBUTION: Europe, rare.

NOTES: Only one collection from Boudier's Herbarium in PC was examined, but our observations certainly agree with Dennis's (1968) description. This fungus was placed in **Cheilymenia** by Le Gal (1947) and Dennis (1968, 1978). There are no rooting hairs, and unlike other Cheilymenias the perispore does not loosen when heated in lactic acid, and the yellow refractive color of the spore wall disappears in 2% KOH. In addition, the marginal hairs with blunt apices when young, and borne in fascicles, are similar to but less differentiated than those of other species of **Tricharina**.

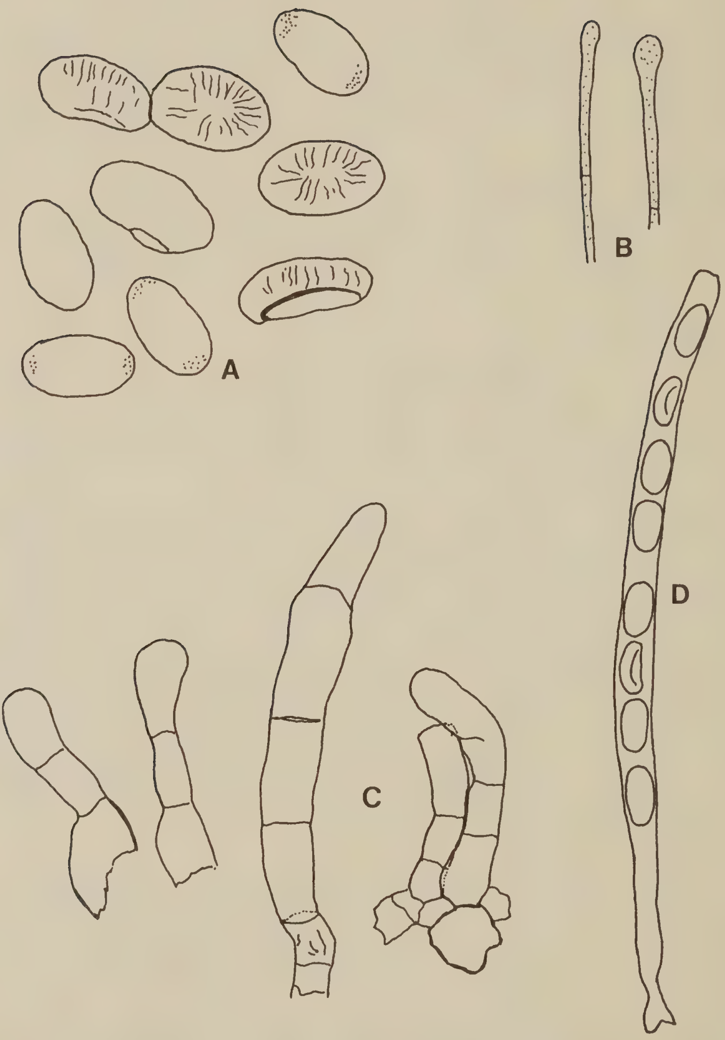


Fig. 8. **Tricharina fibrillosa** (from the holotype). A. Ascospores; note occasional, polar granules and cyanophilic wrinkles in mature, collapsed spores, X 1000. B. Tips of paraphyses, X 500. C. Obtuse, thin-walled marginal hairs, X 500. D. Ascus with 8 ascospores, X500.

HOLOTYPE: In Herb K, examined by Dennis (1968).

SPECIMEN EXAMINED:
PORTUGAL: Lisbonne, Feb. 1908, M. Torrend (PC-Boudier, sub **Tricharia**).

TRICHARINA GILVA (Boud. in Cke.) Eckblad, Nytt Mag. Bot. 15: 60. 1968.
- = **Peziza gilva** Boud. in Cke., Mycographia p. 240, fig. 406. 1879.
  - = **Humaria gilva** (Boud. in Cke.) Sydow, Mycoth. march. #775. 1884 (excl. specim.).
  - = **Lachnea gilva** (Boud. in Cke.) Sacc., Syll. Fung. 8: 184. 1889.
  - = **Scutellinia gilva** (Boud. in Cke.) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.
  - = **Tricharia gilva** (Boud. in Cke.) Boud., Icon. Mycol. Expl. Pl., sér. 1: 8. 1904.
  - = **Patella gilva** (Boud. in Cke.) Seaver, N. Am. Cup-fungi (oper.) p. 166. 1928.
  - = **Trichophaea gilva** (Boud. in Cke.) Gamundí, Revista Mus. La Plata, secc. Bot., 10: 60. 1966.
- = **Peziza fimbriata** Quél. in Cke., Mycographia, p. 240, fig. 405. 1879 (Feb.).
  - = **Lachnea fimbriata** (Quél. in Cke.) Quél., Bull. Soc. Bot. France 25: 291. 1879 (later).
  - = **Scutellinia fimbriata** (Quél. in Cke.) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.
  - = **Tricharia fimbriata** (Quél. in Cke.) Boud., Icon. Mycol. Liste Prélim. p. (3). 1904.
  - = **Trichophaea fimbriata** (Quél. in Cke.) Gamundí, Revista Mus. La Plata, secc. Bot., 10: 60. 1966.
- = **Humaria umbrata** (Fr.) Rehm f. **pallida** Rehm, Ascom. #456. 1878.
  - = **Lachnea umbrata** (Fr.) Phill. var. **pallida** (Rehm) Sacc., Syll. Fung. 8: 174. 1889.
- = **Lachnea lapidaria** Cke. in Phill., Brit. Discom. p. 211. 1887.
  - = [**Peziza lapidaria** Cke. in Phill., Brit. Discom. p. 211. 1887, pro synon.]
  - = **Scutellinia lapidaria** (Cke. in Phill.) Kuntze, Rev. Gen. Pl. 2: 869. 1891.
  - = **Lachnea hybrida** (Sow.) Phill. var. **lapidaria** (Cke. in Phill.) Massee, Brit. Fungus-Fl. 4: 313. 1895.
- = **Lachnea lojkeana** Rehm in Rabenh., Krypt.-Fl. ed. 2, 1(3)[Lief. 44]: 1045. 1895.
- = **Lachnea cinerella** Rehm in Rabenh., Krypt.-Fl. ed. 2, 1(3)[Lief. 45]: 1243. 1896.
- = **Lachnea fuscidula** Velen., Novit. Mycol. p. 195. 1940 (1939?).

MISAPPLICATIONS:
- **Ciliaria umbrata** (Fr.) Quél., by Quélet, Bull. Soc. Sci. Nat. Rouen, ser. 2, 15: 178. 1880 (1879).
- **Humaria luteopallens** (Nyl.) Rehm, by Rehm, Fungi lojkani, p. 2. 1882.
- **Lachnea umbrata** (Fr.) Phill., by Phillips, Brit. Discom. p. 222. 1887; by Saccardo, Syll. Fung. 8: 174. 1889; by Rehm in Rabenh., Krypt.-Fl. ed. 2 1(3)[Lief. 44]: 1051. 1895.

Peziza hybrida Sow., by Cooke, Grevillea 12: 43. 1883.
Peziza umbrosa Fr., by Rabenhorst, Fungi Eur. Exs. #217. 1860.
Peziza umbrata Fr., by Karsten, Not. Sällsk. Fauna Fl. Fenn. Förh. 10: 125. 1869; by Cooke, Mycographia p. 76, pl. 35, fig. 137. 1876.
Pyronema luteopallens Nyl., by Rehm, Ascom. #7. 1870.

ILLUSTRATIONS:
Boudier, Icon. Mycol. 2: pl. 347. 1904. (**Tricharia gilva**); pl. 348. 1910. (**Tricharia fimbriata**).
Cooke, Mycographia pl. 113, fig. 405. 1879. (**Peziza fimbriata**); pl. 113, fig. 406. 1879. (**Peziza gilva**); pl. 35, fig. 137. 1876. (**Peziza umbrata**).
Dennis, Brit. Cup Fungi pl. VIA. 1960. (**Tricharia gilva**).
Dennis, Brit. Ascom. pl. VIA. 1968. (**Tricharia gilva**).
Dennis, Brit. Ascom. ed. 2 pl. IXA. 1978.
Eckblad, Nytt. Mag. Bot. 15: 60, fig. 24. 1968. (doubtful).
Gamundí, Revista Mus. La Plata, secc. Bot. 10: pl. IV 1-9, V 1-2. 1966. (doubtful; as **Trichophaea fimbriata**).
Svrček, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 4(6): tab. I, fig. 10-11, tab. XI. 1949. (**Lachnea gilva**).
This paper, Figs. 2A, B; 6C-E; 9.

EXSICCATAE:
Rabenhorst, Fungi Europ. #217 (**Peziza umbrosa**)
Rehm, Ascom. #7 (**Pyronema/Peziza luteopallens**)
Rehm, Ascom. #456 (**Humaria umbrata f. pallida**)
Rehm, Ascom. #1154 (**Lachnea cinerella**)
Sydow, Myc. march. #4173 (**Lachnea cinerella**)

Apothecia small, 3-9 mm diam, broadly sessile, cupulate to discoid; **hymenium** 130-200 µm thick, pale brownish to yellowish brown; **hairs** marginal, fasciculate, subhyaline to pale brown, 3-8 septate, 180-400 µm long, 9.5-15.0 µm broad near the base, wall 1.0-2.5 µm thick, apices pointed to rounded, mixed with some pale brown, elongated cells; **excipulum** two-layered, 80-220 µm thick, ental layer of textura intricata, ectal layer of textura globulosa to textura angularis, composed of inflated, thin-walled cells 20.5-26.1 x 23.5-33.6 µm, slightly radially elongated, the outermost 1-2 layers of cells with pale brown walls 0.5-1.5 µm thick; **asci** cylindrical, narrowing towards the base, 11.2-16.8 x 130-180 µm, 8-spored, J-; **ascospores** broadly ellipsoid, smooth, eguttulate or with occasional inclusions of polar granules, uniseriate, hyaline or yellow-refractive when mature and mounted in lactic acid, 7.3-9.5 x 12.4-15.4 µm; **paraphyses** slender, septate, 2.0-2.5 µm broad, slightly enlarged to 3.5-4.5 µm near apex, branched near base.

HABITAT AND SUBSTRATE: on soil or humus, or on old burnt places overrun with mosses.

ETYMOLOGY: from the yellowish color of the apothecium.

ANAMORPH: **Ascorhizoctonia gilva** Yang & Korf.

DISTRIBUTION: Europe, North America, Jamaica.

NOTES: Although **Tricharina gilva** and **Peziza fimbriata** are synonymized here, a few minor differences in the type specimens of these names can be recognized. The type of **P. fimbriata** possesses longer hairs, up to 400 µm long, with more septa per hair (5-8). The type of **Tricharina gilva** has hairs up to 220 µm long and usually with 5 or fewer septa per hair. These differences are not consistent and intermediates are found in other collections.

Though Cooke (1879) pointed out that the type of **P. fimbriata** has slightly larger spores and only marginal hairs, our measurements show the spores of both type specimens to be in the same range and both have hairs confined to the margin. Cooke's spore measurements (17-18 µm long) for **P. fimbriata** are 2-3 µm longer than those given by Quélet (1879: 15 µm long) for the same collection. We are convinced that Cooke measured only the largest spores, considering them to be mature, but mature spores are actually smaller than either immature or barely mature spores.

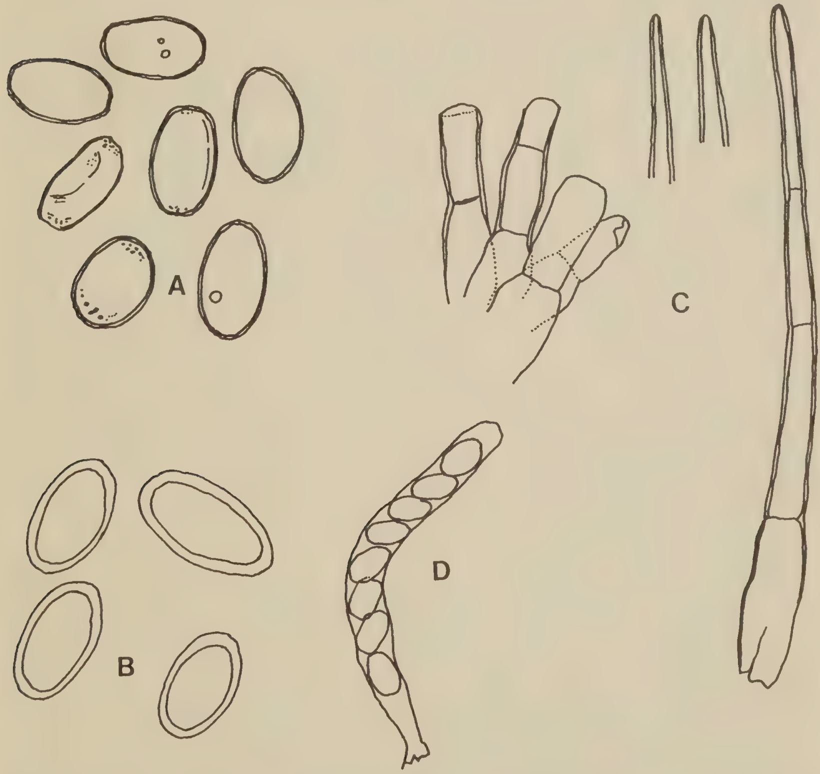


Fig. 9. **Tricharina gilva** (from the lectotype). A. Mature and postmature ascospores; note polar granules in some spores, X 1000. B. Immature ascospores with larger spore size, thick wall visible due to staining of cytoplasm, X 1000. C. Marginal hairs with blunt to pointed tips, X 500. D. Ascus with 8 ascospores, curvature due to squash mount preparation, X 500.

Several specimens assignable to either species were germinated and cultured, and the anamorphs are identical (Yang and Korf, 1985).

We have decided to retain the name **T. gilva** for the combined species. Although Quélet's name **Lachnea fimbriata** has been cited as being published in 1878 (Boudier, 1907; Gamundí, 1966), the correct year of publication is 1879 (Donk, 1964). Quélet (1879) not only was aware of Cooke's (1879) treatment based on material Quélet had sent, but he actually cited Cooke's figure number in his description. Therefore, in the absence of exact dating of the volume in which Quélet's paper appeared, we have concluded that Cooke's treatment, which appeared in February, 1879, must have been published earlier than Quélet's, and thus we treat Quélet's name as a transfer, not as a new species. Both **Peziza gilva** and **P. fimbriata** were first described on the same page and illustrated on the same plate in 1879 in Cooke's Mycographia. Our reason for selecting **Tricharina gilva** here is that it is a far more commonly used name than is **Tricharia fimbriata**, and we also avoid making a new combination thereby.

Gamundí (1966) transferred both **Tricharia gilva** and **T. fimbriata** to **Trichophaea**, apparently recognizing them to be two, distinct species, but she did not mention any criteria for separating them. Her drawings of ascospores from the Argentinian material (pl. IV, figs. 5, 7), with pointed to rounded ends, are more similar to spores of **Tricharina ochroleuca** than they are to those of **T. gilva** (**Tricharia fimbriata**). She was also able to germinate ascospores, which yielded a fast-growing mycelium recalling **Ascorhizoctonia** (pl. V, figs. 1, 2). Direct comparisons with the anamorphs we obtained (Yang and Korf, 1985) were not made by us due to the different nutrient media she used.

Tricharina gilva was not originally described as a fire-site fungus, but collected from soil (Cooke, 1879; Boudier, 1904-1911), but over time the name came to be used to denote a fire-site fungus. Seaver (1928) was probably the first person to describe **T. gilva** from an old burnt place overrun with mosses, and his specimen at NY is indeed conspecific with **T. gilva**. Most specimens from fire sites are assignable to either **T. praecox** var. **praecox** or var. **cretea**. Occasionally, however, other species of **Tricharina**, or even of **Wilcoxina**, may be found on old burnt places.

HOLOTYPE: [collector unknown], terra culta, Montmorency [France], no date (PC-Boudier).

OTHER SPECIMENS EXAMINED:

ALGERIA: J. Moravec, on soil among mosses, Kabilia, Tizi-Puzon, 31.v.1975 (CUP 61623 ex Herb. J. Moravec).

AUSTRIA: H. Lojka, Pfarrgartens bei Gelsendorf, Stryjer Estmitat, Galizien, 10.8.1869 (S-Sydow); also issued as Rehm, Ascom. #7 (S).

BELGIUM: Eugène Coemans, ad. Gandavum (Flandria), no date, Rabenh. Fungi eur. #217 (BPI).

CZECHOSLOVAKIA: J. Moravec, on moist soil in forest, district of Brno, Moravia, 10.viii.1973 (CUP 61624 ex Herb. J. Moravec); J. Moravec, on destroyed wall mixed with sand, mortar, bricks, and mosses, Branžež near Mnichovo-Hradiště,6.viii.1967 (CUP 61627 ex Herb. J. Moravec); J. Moravec, on bare soil of a hollow way between fields overgrown with a bush, Branžež near Mnichovo Hradiště, Bohemia, 12.vi.1966 (CUP 61629 ex Herb. J. Moravec); A. Pilát, in carbonariis m. Carpat, pr. Třebušany (1000), Aug. 1935

(PRM 15018, holotype of **Lachnea fuscidula**); A. Pilát, Carpatorossia, in silvis mixtis birgineis (**Abies alba**, **Picea excelsa**, **Fagus silvatioca** etc.) in valle rivi Bily Potok prope vicum Trĕbušany (800-1500), 4-11.x.1935 (PRM 23191); J. Kubička et L. Kubičkova, ad terram loca ruderato, Trebon:Lazne, 19.v.1964 (PRM 611371); J. Kubička, in horto publico, Trebon, 18.iv.1960 (PRM 620639); M. Svrček, in cumulo cinere, Divoka Sarka, 10.vii.1948 (PRM 756474).

DENMARK: H. Dissing, on soil mixed with old charcoal, Sjarlland, 6.5.1964 (C); collector unknown, on soil, S 73.050 (C).

FRANCE: M. L. Quélet, on the ground, Vosges, no date (K-Cooke, holotype of **Peziza fimbriata**); R. Maire, Caen, Martio 1911 (PC-Boudier); M. Hetier, ad corium putridum, Arbois, Aug. 1902 (PC-Boudier); M. Hetier, in quisquiliis carboni mixtis, Arbois, Aug. 1902 (PC-Boudier); D. Legue, Montdoubleau, 1901 (PC-Boudier); L.-J. Grelet, on soil, 12 mais 1929 (PC-Grelet); L.-J. Grelet, 3 oct. 1924 (PC-Grelet); collector unknown, no data (PC); E. Boudier, Jura, no date (S-Bresadola).

GERMANY: Buchs, Polen: Oberschlesien, Zulu, 1905 (S-Rehm); Britzelmayr, Augsburg auf Kalkboden zwischen Asche in einem Hansgarten, 5/1878, Rehm, Ascomyceten #456 (NY, isotype of **Humaria umbrata f. pallida**); P. Sydow, auf einem Aschenhaufen, Lichterfelde bei Berlin, 6.1894, Rehm, Ascomyceten #1154 and Sydow, Mycoth. march. #4173 (K, isotypes of **Lachnea cinerella**).

GREAT BRITAIN: [Cedric Bucknall], no date, between paving stones in an area, Bristol, (K-Cooke, holotype of **Lachnea lapidaria**); Collector unknown, on soil, May 29, 1888 (K-Phillips); collector unknown, on soil, 22.9.1888 (K-Phillips); W.D. Graddon, on a cinder heap, April 1945 (K); W.D. Graddon, on lime soil of river bank, 23.7.1955 (K); H.T. Soppitt, on bare ground in seams between paving stones in warehouse yard, Halifax, July 24, 1897 (K-Crossland).

GREENLAND: S. Sivertsen & H. Dissing, on naked sand, Aug. 6, 1982 (C-GR 82.123).

ITALY: G. Bresadola, as terram limosam, Aprile 1898 (PC-Boudier).

JAMAICA: R.P. Korf, J.R. Dixon, K.P. Dumont, R.W. Erb, D.H. Pfister, D.R. Reynolds, A.Y. Rossman & G. Samuels, on soil, near Dick's Pond, west of Hardwar Gap, near Holywell Recreation Area, St. Andrew's Parish, elev. 2800-3000', Jan. 11, 1971 (CUP-MJ 330).

NORWAY: F.-E. Eckblad #58/5, on soil, Breistolen, 12/8-1958 (O); H. Dissing & S. Sivertsen #79-108, in sandy clay in rubbish dumps, 18.8.1979 (TRH); H. Dissing & S. Sivertsen #82-88, on moist, loose silt without vegetation in brook bed, breaking through surface in **Geopora**-like manner, 6/8 1982 (TRH); S. Sivertsen #79-226, on soil, 25/9 1979 (TRH).

SWITZERLAND: V. Tavel, im Garten der eidgenossischen Samen-Controllstation in Zürich, 5-1891 (S-Rehm, here designated the LECTOTYPE of **Lachnea lojkeana** Rehm).

U.S.A.: F.J. Seaver, on mosses, on an old burnt place, Yonkers, NY, Oct. 6, 1916 (NY); collector unknown [Seaver's handwriting], on soil, no date, no locality, (NY, sub. **Lachnea ochracea** ined.); J.W. Lorbeer, on soil under leaf duff and among grasses under an apple hedgerow between vegetable fields, Agr. Expt. Station Vegetable Farm, Geneva, NY, 16.v.1973 (Herb. R.P. Korf #4128); J.W. Paden #246, on burned soil, Robinson Lake, Latah Co., Idaho, Aug. 31, 1964 (ID).

TRICHARINA GROENLANDICA Dissing, Yang & Korf, **sp. nov.**

ILLUSTRATIONS: This paper, figs. 2C, 6G, 10.

Ab speciebus aliis ***Tricharinae*** *pilis marginalibus ad cellulas brunneas parietes crassos possidentes et in seriebus dispositas reductis differens.*

Apothecia small, 2.0–4.5 mm broad, broadly sessile, at first cup-shaped, later expanded to saucer-shaped, margin dentate; **hymenium** sienna, 150–190 µm thick; **subhymenium** 18–28 µm thick; **margin** composed of thick-walled, brown cells forming rows, with occasional, rudimentary, short, subhyaline **hairs** protruding from the flanks near the margin; **excipulum** two-layered, ental layer of textura intricata, 40–75 (–112) µm thick, ectal layer of textura globulosa, 75–120 µm thick, composed of 5-7 layers of inflated cells 15.0–25.0 x 19.0–30.0 µm, the outermost cell layer with pale brown walls 0.5 µm thick; innermost layers thin-walled, hyaline; **asci** cylindrical, 8-spored, 12.0–15.0 (–16.8) x 170–190 µm, J–; **ascospores** ellipsoid, smooth, eguttulate but with strong polar granules, hyaline or yellow-refractive when mature and mounted in lactic acid-containg media, 7.5–9.2 (–10.2) x (13.6–) 13.9–17.6 µm; **paraphyses** slender, septate, containing some small pale brownish particles, 2.2–3.0 µm broad, slightly enlarged to 3.7–5.1 µm near apex.

HABITAT AND SUBSTRATE: under **Salix** together with **Triglochin palustre** in naked clay soil.

ETYMOLOGY: from the type locality, Greenland.

ANAMORPH: **Ascorhizoctonia groenlandica** Yang & Korf.

DISTRIBUTION: Known only from the type locality.

NOTES: This species differs markedly from others in the genus in its possession of only a few, rudimentary, short hairs intermixed with rows of relatively undifferentiated, thick-walled, brown cells in rows at the margin, not unlike those found between fascicles of hairs in other species of the genus.

HOLOTYPE: on naked, clayey soil under **Salix**, Sdr. Stromfjord, 66 55'N, 50 35' W, near the airport, leg. H. Dissing #Gr 83.03, July 20, 1983 (C).

TRICHARINA HIEMALIS YANG & Korf, **sp. nov.**

MISAPPLICATIONS:

- **Trichophaea** cfr. **bullata** Kanouse, by Whitney and Parmeter, Mycologia **56**: 114-118. 1964.
- **Trichophaea** sp., by Warcup and Talbot, Trans. Brit. Mycol. Soc. **49**: 432. 1966.

ILLUSTRATIONS:

- Whitney and Parmeter, Mycologia **56**: 115, figs. 1-3. 1964 (as **Trichophaea** cfr. **bullata** Kanouse.
- This paper, figs. 2F, 11.

*Ab **Tricharina gilva** et **T. ochroleuca** texturis apothecialibus firmis (ceraceis), ascosporis perpaucis maturescentibus differens.*

Apothecia small, 2–6 mm diam, broadly sessile, cupulate, becoming discoid to somewhat scutellate, waxy; **hymenium** whitish, yellow-orange to gray, 150–180 µm thick; **hairs** marginal, in

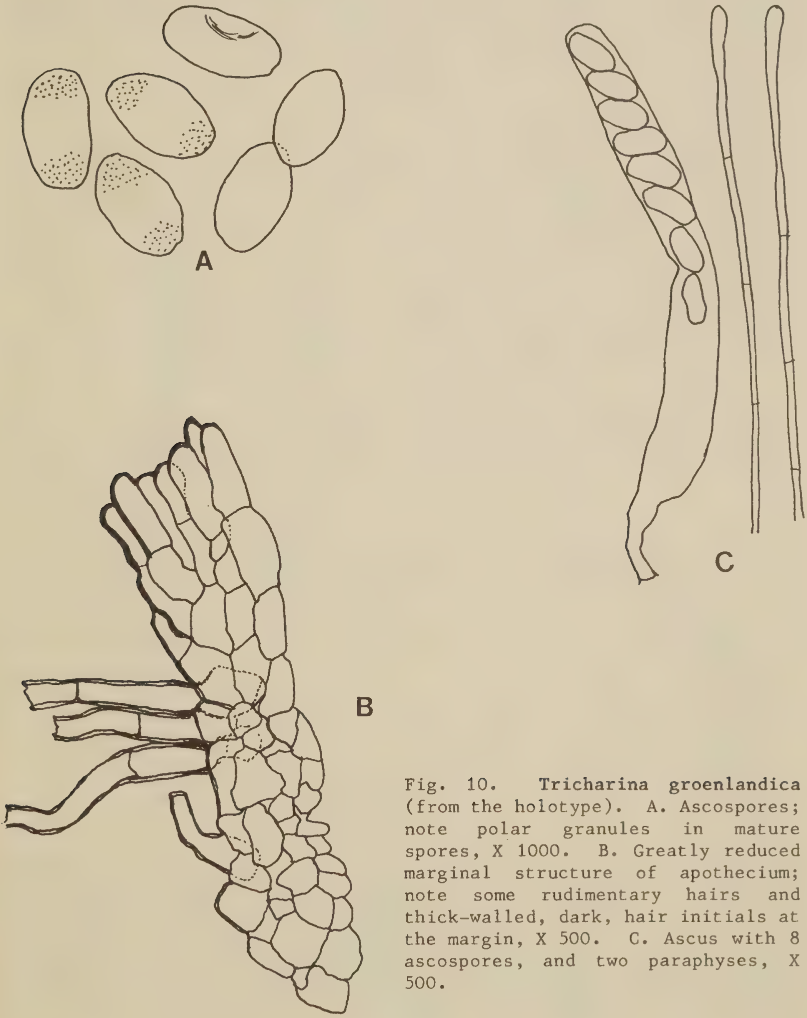


Fig. 10. **Tricharina groenlandica** (from the holotype). A. Ascospores; note polar granules in mature spores, X 1000. B. Greatly reduced marginal structure of apothecium; note some rudimentary hairs and thick-walled, dark, hair initials at the margin, X 500. C. Ascus with 8 ascospores, and two paraphyses, X 500.

fascicles, pale brown, septate, 9.3-13.0 (-14.5) x 220-300 (-450) µm, tapering to a rounded apex, wall 1.5-2.0 µm thick; **excipulum** two-layered, 200-330 µm thick, ental layer of textura intricata, ectal layer of textura globulosa to textura angularis, the outermost 1-3 cell layers composed of inflated, brown, thick-walled (0.7-1.5 µm), nearly globose cells, often collapsed, the inner ectal excipulum of 3-5 layers of thin-walled, hyaline, isodiametric cells; **asci** cylindrical, narrowing toward base, 8-spored, 9.0-13.0 x 150-160 µm, J-; **ascospores** ellipsoid, smooth, eguttulate, with or without polar granules, with only a few spores mature, hyaline to refractive-yellow when mature and mounted in lactic acid-containing media, (6.6-) 7.3-8.8 x (11.7-) 13.2-15.4 µm; **paraphyses** slender, septate, branched near base, slightly enlarged towards apex to 3.5-4.0 µm.

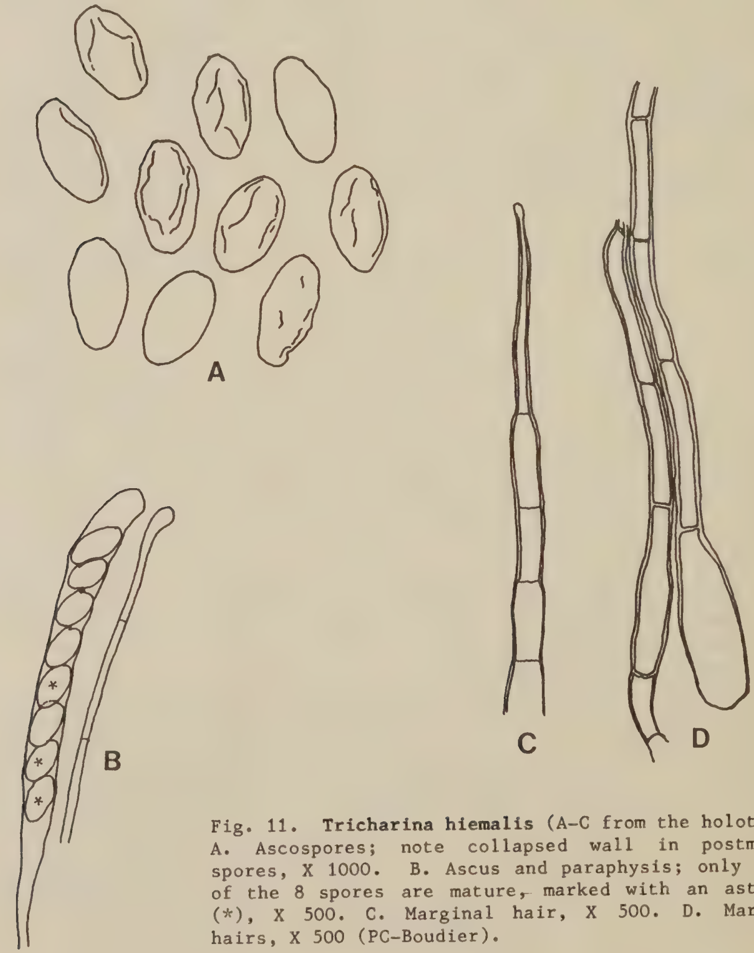


Fig. 11. **Tricharina hiemalis** (A-C from the holotype). A. Ascospores; note collapsed wall in postmature spores, X 1000. B. Ascus and paraphysis; only three of the 8 spores are mature, marked with an asterisk (*), X 500. C. Marginal hair, X 500. D. Marginal hairs, X 500 (PC-Boudier).

HABITAT AND SUBSTRATE: on soil.

ETYMOLOGY: derived from the anamorphic epithet, i.e., of the winter.

ANAMORPH: **Ascorhizoctonia hiemalis** (Saksena & Vaartaja) Yang & Korf.

DISTRIBUTION: Canada and Europe.

NOTES: The culture of the anamorph was induced to produce apothecia in vitro with a soil-on-agar method by Whitney and Parmeter (1964) and by Warcup and Talbot (1966); the apothecia were assigned to **Trichophaea** in both papers. The specimen deposited by Talbot at Kew was labelled **Tricharia** (Dennis's hand?) and is a **Tricharina** with eguttulate ascospores and fasciculate, marginal hairs.

The apothecial tissues of this fungus are bound together tightly and appear waxy during sectioning. This species is close to **T. ochroleuca.** The spore shape in both species is ellipsoid with rounded ends. Two characters can be used to separate these: (1) In **T. hiemalis** only a few spores are mature in each section, while in **T. ochroleuca** most spores are mature, and (2) the ectal excipulum in **T. ochroleuca** is simpler, with an ectal layer of only a few rows of inflated cells.

The paucity of collections would indicate that this fungus rarely fruits in natural habitats. Only two other collections, both from Europe, were seen during this study, one of which had been identified as **Tricharia praecox** by Boudier.

HOLOTYPE: Perfect state of **Rhizoctonia hiemalis** developed in culture by P.H.B. Talbot, S. Australia, June 1964 (K). The culture of **R. hiemalis** was originally isolated from forest soil in Canada (Saksena and Vaartaja, 1960).

OTHER SPECIMENS EXAMINED:

CZECHOSLOVAKIA: J. Moravec, on soil, in the center of the town Mladá Boleslav, Bohemia, 18.x.1967 (CUP 61631 ex Herb. J. Moravec).

FRANCE: M. Hariot, as **Tricharia praecox** (no. 2), on soil, no date (PC-Boudier).

TRICHARINA JAPONICA Yang & Korf, sp. nov.

ILLUSTRATIONS: This paper, figs. 6F, 12.

*Ab speciebus aliis **Tricharinae** pilis perlongis (400-820 µm) flexuosis et ascosporarum forma trapezoidea differens.*

Apothecia small, up to 10 mm diam after rehydration, shallow cupulate and expanding to discoid; **hymenium** whitish, 180-220 µm thick; **hairs** in fascicles, marginal, pale brown, septate, flexuous, tapering to rounded apices, 5.5-8.5 x 400-820 µm; **excipulum** two-layered, ental layer of textura intricata, 50 µm thick near margin, 90-110 µm thick near base, ectal layer of textura globulosa to textura angularis, 50 µm thick near margin and up to 140 µm thick near base, composed of inflated, thin-walled, hyaline cells mixed with some brown, thick-walled cells near the margin, basal anchoring hyphae common, arising from globose, inflated cells of the outermost layer of the ectal excipulum; **asci** cylindrical, narrowing towards base, 8-spored, 11.2-13.1 x 150-210 µm, J-; **ascospores** ellipsoid with pointed ends to trapezoidal, smooth, eguttulate but with occasional polar granules, uniseriate, yellow-refractive when mature and mounted in lactic acid-containing media, 7.3-9.5 xx 15.8-19.0 µm; **paraphyses** slender, septate, 2.0-2.5 µm broad, equal or slightly enlarged to 3.5-5.0 µm near apex.

HABITAT AND SUBSTRATE: on soil.

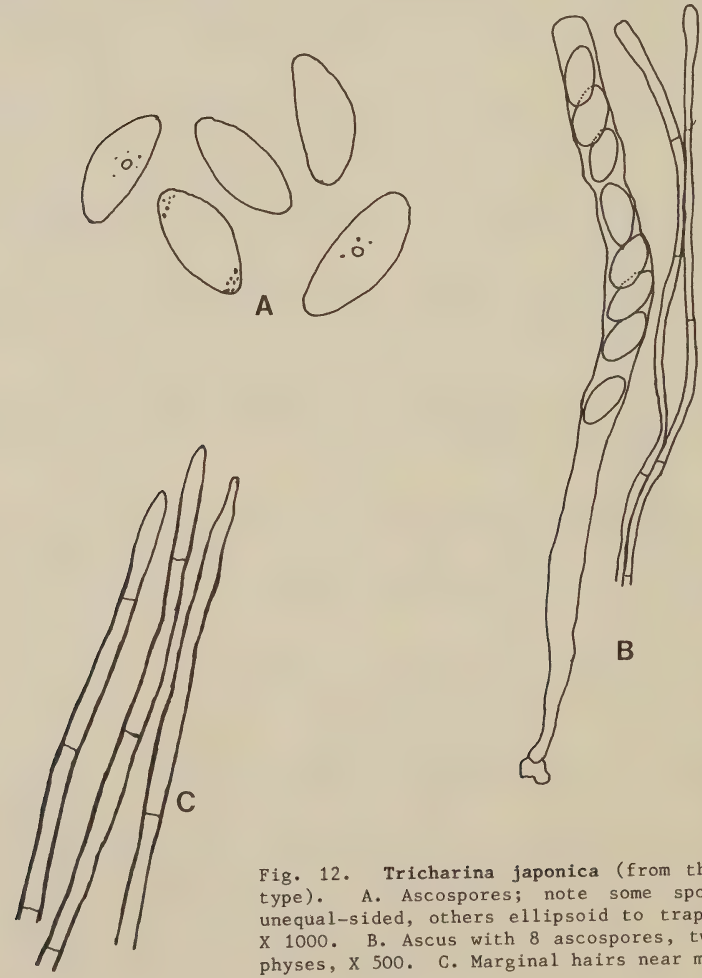


Fig. 12. **Tricharina japonica** (from the holotype). A. Ascospores; note some spores are unequal-sided, others ellipsoid to trapezoidal, X 1000. B. Ascus with 8 ascospores, two paraphyses, X 500. C. Marginal hairs near margin, X 500.

ETYMOLOGY: from the country, Japan, where the holotype was collected.

DISTRIBUTION: known only from the type locality.

NOTES: This is an easily recognizable species by virtue of its long, flexuous hairs and its possession of some distinctly trapezoidal ascospores.

HOLOTYPE: on soil, Mt. Tachibana, near Fukuoka, Fukuoka Pref., Kyushu, Japan, Leg. S. Imai, H. Yoshii, R. P. Korf, et al., 28.x.1957 (CUP-JA 286); (ISOTYPES in TNS and in Herb. R. P. Korf.)

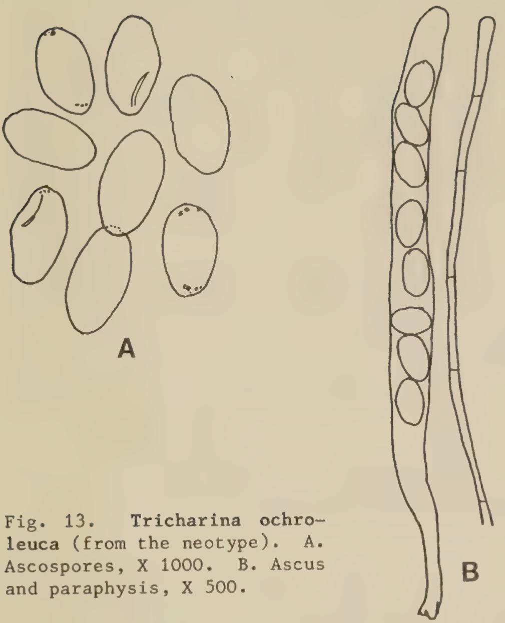


Fig. 13. **Tricharina ochroleuca** (from the neotype). A. Ascospores, X 1000. B. Ascus and paraphysis, X 500.

TRICHARINA OCHROLEUCA (Bres.) Eckblad, Nytt Mag. Bot. 15: 61. 1968.

= **Peziza ochroleuca** Bres., Fungi Trid. 1(7): 92. 1887; Hedwigia 26: 219. 1887.
= **Lachnea ochroleuca** (Bres.) Sacc., Syll. fung. 8: 182. 1889.
= **Scutellinia ochroleuca** (Bres.) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.
= **Tricharia ochroleuca** (Bres.) Boudier, Icon. Mycol. Liste Prélim., p. (3). 1904.

MISAPPLICATIONS:

Tricharina cretea, by Moravec, Česká Mykol. 28: 20. 1974; by Thind and Kaushal, Indian J. Mycol. Plant Pathol. 9: 228. 1979.

ILLUSTRATIONS:

Boudier, Icon. Mycol. 2: pl. 350. 1908. (**Tricharia**).
Bresadola, Fungi Trid. 1, pl. 104, fig. 2. 1887. (**Peziza**). (His hairs are clustered but too sharp for **Tricharina**.)
Bresadola, Icon. Mycol. 25: pl. 1239, fig. 2. 1933. (**Lachnea**).
Eckblad, Nyttl Mag. Bot. 15: 61, fig. 25. 1968.
Thind and Kaushal, Indian J. Mycol. Plant Pathol. 9: 227, fig. 4. 1979. (**Tricharina cretea**).
This paper, figs. 2E, 6H, I; 13.

Apothecia small, 2.5-12 mm diam, broadly sessile to somewhat submerged, solitary to gregarious, cupulate, expanded to discoid; **hymenium** white-gray, ochraceous, to pale fawn, 150-220 µm thick; **hairs** marginal, fasciculate, subhyaline towards apex and becoming brown near base, 11.2-14.9 µm broad near base, 220-330 µm long, mostly 5-8-septate, wall 0.5-1.5 mm thick, with blunt to pointed apices; **excipulum** two-layered, thick when fully rehydrated, ental layer of textura intricata, indistinguishable from subhymenium, 40-70 µm thick, ectal layer of textura angularis to textura globulosa, 120-220 µm thick, composed of mostly thin-walled, hyaline, slightly radially elongated cells, the outermost cell layer pale brown, thick-walled (walls 0.5-1.0 µm thick); **asci** cylindrical, narrowing toward base, 8-spored, 9.5-11.7 x 130-170 µm, J-; **ascospores** ellipsoid, uniseriate, smooth, eguttulate with polar granules, hyaline or yellow-refractive when mature and mounted in lactic acid-containing media, (7.0-) 7.3-9.5 x 12.8-15.4 (-16.8) µm; **paraphyses** slender, septate, 1.5-3.0 µm broad, gradually enlarged to 3.5-4.0 µm wide at apex.

HABITAT AND SUBSTRATE: on soils.

ETYMOLOGY: from the color of the apothecium.

ANAMORPH: **Ascorhizoctonia ochroleuca** Yang & Korf.

DISTRIBUTION: Europe, India.

NOTES: There are three authentic specimens in Herb. Bresadola at S. One of the three was sent from Boudier without date but indication that it was from Jura, and thus cannot be holotypic material. The specimen in this packet is assignable to **Tricharina gilva**. Another collection is dated 1906, too late to be holotypic material, and contains specimens of a **Scutellinia** with guttulate and ornamented ascospores. The third collection has two partial apothecia only, and is without collection data. It may be original material, but there is certainly no proof of that. One of the apothecia is a **Tricharina**, and the other is referable to **Cheilymenia**. Because the apothecium belonging to **Tricharina** could not be placed with any other recognized species, we use the characters associated with that apothecium as a basis for a concept for Bresadola's name, but here designate an ample Norwegian collection with matching characters as the NEOTYPE. There is no specimen left at PC with data corresponding to that illustrated by Boudier (**1904-1911**). The major distinguishing character between this species and **T. gilva** is spore shape. The spores in **T. ochroleuca** are ellipsoid, narrowing to two rounded ends (Figs. 6C-E, 13), while the spores of **T. gilva** are more broadly ellipsoid with almost truncate ends (Figs. 6H, I; 9 A, B, D).

NEOTYPE SPECIMEN: (designated here) on naked, sandy soil, Nordland, Norway, leg. S. Sivertsen & H. Dissing #MO 79.76, Aug. 18, 1979 (C); isoneotype: CUP 61601.

OTHER SPECIMENS EXAMINED:

CZECHOSLOVAKIA: J. Moravec, on soil on a street in the town of Mladá Boleslav, 7.ix.1967 (CUP 61628 ex Herb. J. Moravec); J. Moravec, on soil among moss, Branžež, District of Ml. Boleslav near Mnichovo Hradiště, 5.vi.1966 (CUP 61630 ex Herb. J. Moravec).

DENMARK: E. Rostrup, on soil in a flower pot, 10. Sept. 1894 (C); H. Dissing #63.194, on sandy, clayey soil, Sjaelland, 1.8.1963 (C).

GREAT BRITAIN: C. Crossland & G. Massee, on soil, base of wall, near the "paper mill," Oct. 4/1908 (K-Crossland); collector unknown, Phillis wood, mud-color, cart rut, 24/7/1969 (K); C. Crossland & J. Needham, in sandy ground among moss, river side, Hebden Bridge, Sept. 1905 (K-Crossland); J. Needham, on sandy soil, river side, Foster Mill, Hebden Bridge, Yorks., Sept. 1905 (K-Needham); C. Crossland & J. Needham, on soil among moss, river side, Hebden Bridge, no date (NY-Massee).

GREECE: J. Moravec, on bare soil, Levadia, 17.v.1971 (CUP 61632 ex Herb. J. Moravec).

GREENLAND: H. Dissing #GR 83.107, on sandy soil, St. Blydal, Aug. 7, 1983 (C).

INDIA: K. Waraitch, on moist soil, on the foot path in mixed forest, Bhadarwah, Doda, J&K, Sep. 30, 1967 (PAN 2163).

LOCALITY UNKNOWN: collector unknown, as **Lachnea ochroleuca**, no date, [authentic] (S-Bresadola: one of the two apothecia, the other being a **Cheilymenia** sp.).

TRICHARINA PALLIDISETOSA (Cash) Thind & Kaushal, Indian J. Mycol. Plant Pathol. 9: 228. 1979.
= **Humaria pallidisetosa** Cash, Mycologia **40**: 725. 1948.

ILLUSTRATIONS: This paper, Fig. 14.

Apothecia small, fleshy, 6–8 mm broad, drying 5–6 mm broad, shallow cupulate, drying cinnamon drab, margin minutely denticulate; **hymenium** wood brown to drab, 210–230 µm thick; **hairs** marginal, fasciculate, septate, subhyaline to pale brownish, flexuous, with basal cell 8.0–10.0 µm broad, tapering to rounded tips, 250–300 µm long, wall up to 1.5 µm thick; **excipulum** two-layered, ental layer of textura intricata, 110–160 µm thick, ectal layer of textura globulosa, 40–60 µm thick, composed of inflated, yellowish, thick-walled (up to 1.0 µm thick) cells in 2–5 cell layers, thick-walled basal anchoring hyphae with bulbous basal cell extending from the outermost cell layer; **asci** cylindrical, narrowing toward base, 8-spored, 13–15 x 190–230 µm, J–; **ascospores** ellipsoid, uniseriate, smooth, eguttulate with polar granules, hyaline or yellow-refractive when mature and mounted in lactic acid-containing media, 8.4–11.2 x (15.9–) 16.8–20.5 µm; **paraphyses** slender, septate, 3.4 µm wide near apex.

HABITAT AND SUBSTRATE: on ground.

ETYMOLOGY: from the pale-colored hairs.

ANAMORPH: unknown.

DISTRIBUTION: known only from the type locality.

NOTES: This species is known from a single collection. The spore size is probably the largest among Tricharinas. Although Cash (1948) considered the fungus to be close to **Patella gilva** sensu

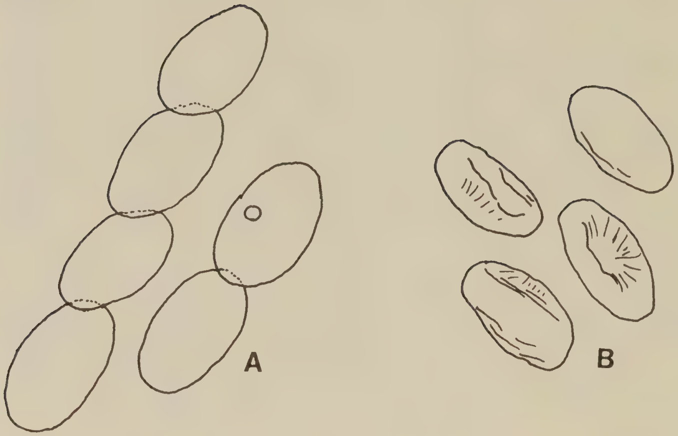


Fig. 14. **Tricharina pallidisetosa** (from the holotype, X 1000). A. Immature ascospores. B. Mature ascospores; note spores collapsed and cyanophilic wrinkles on spores.

Seaver, the large spores make it easy to separate this fungus from other Tricharinas. The type specimen in BPI was in poor condition. We were not able to revive the excipular tissues well, even in 2% KOH, and thus the measurements for the excipulum may be understated.

HOLOTYPE: on the ground, Rohtak, Punjab, India, leg. S. Ahmad #1776, Jan. 17, 1947 (BPI).

TRICHARINA PRAECOX (Karst.) Dennis, Kew Bull. **25**: 338. 1971 var. PRAECOX
= **Peziza praecox** Karst., Not. Sällsk. Fauna Fl. Fenn. Förh. 10: 124. 1869.
= **Lachnea praecox** (Karst.) Sacc., Syll. Fung. **8**: 183. 1889.
= **Scutellinia praecox** (Karst.) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.
= **Tricharia praecox** (Karst.) Boud., Icones Mycol. Liste Prélim. p. (3), 1904.
= ? **Neottiella microspora** Cke. & Massee in Massee, Grevillea **22**: 44. 1893 fide Dennis, Kew Bull. **25**: 339. 1971.

MISAPPLICATIONS:
Tricharina gilva (Boud. in Cke.) Eckbl. by Petersen, Friesia 10: 270-280. 1975 (pro parte); by Thind and Kaushal, Indian J. Mycol. Plant Pathol. **9**: 225-230. 1979.

ILLUSTRATIONS:

Boudier, Icones Mycol. 2: pl. 349. 1908. (**Tricharia**).
Dennis, Kew Bull. **25**: 339, fig. 6. 1971. (**Tricharina praecox**).
Thind and Kaushal, Indian J. Mycol. Plant Pathol. 9: 227, figs. 1-2. 1979. (**Tricharina gilva**).
This paper, figs. 6J, 15.

Apothecia small, 2-3 (-5) mm broad, sessile, pyrophilous, deeply cupulate, expanding to shallow cupulate or hemisphaerical, sunken into substrate, apothecial primordia probably starting beneath the burnt surface, exterior surface grayish to pale brown, apothecial margin extending over the hymenium; **hymenium** brick-colored,

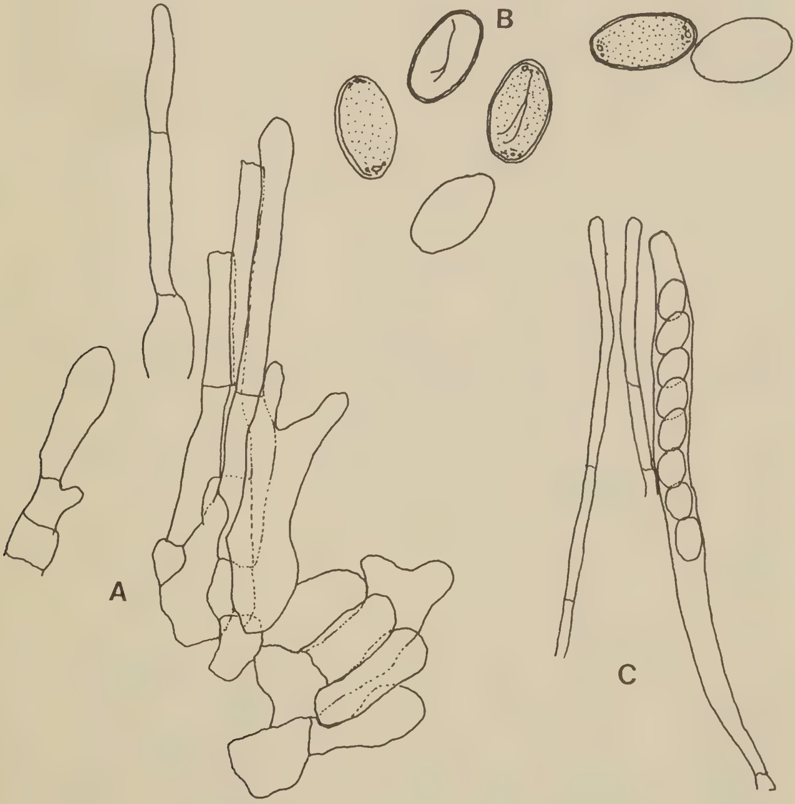


Fig. 15. **Tricharina praecox** var. **praecox** (from the lectotype). A. Marginal hairs; note some are branched, X 500. B. Ascospores; note randomly distributed, cyanophilic dot-like warts on spore surface and a few, polar, granules, X 1000. C. Ascus with 8 ascospores, two paraphyses, X 500.

grayish-ochraceous, or yellowish, drying gray to grayish brown, 170-210 µm thick; hairs marginal, fasciculate, flexuous, almost hyaline to pale brown, 120-200 µm long, 7.0-13.0 µm broad at base, blunt, tapering to rounded apices as hairs elongate, occasionally branched near apex, 3-8-septate; **excipulum** two-layered, 100-130 µm thick, ental layer of textura intricata, 25-35 µm thick, with hyaline hyphae 3-5 µm wide, ectal layer of textura globulosa to textura angularis, 70-100 µm thick, composed of radially elongated, inflated cells up to 20.0-22.0 x 30.0-32 µm, the outermost layer with pale brownish walls, hyaline anchoring hyphae arising from bulbous basal cells of the outermost layer of the ectal excipulum; **asci** cylindrical, narrowing toward base, 9-13 x 160-180 µm, 8-spored, J-; **ascospores** ellipsoid, with length to breadth ratios near 1.5, hyaline or yellow-refractive when mature and mounted in lactic acid-containing media, mature spores often ornamented with delicate, dispersed, cyanophilic dot-like markings, eguttulate but with polar granules as inclusions up to 1.5 µm diam, 8.0-10.0 x (12.5-) 13.0-15.5 (-16.0) µm; **paraphyses** slender, septate, 2.0-3.0 x 160-180 µm, slightly enlarged to 3.5-4.0 µm near apex.

HABITAT AND SUBSTRATE: in ash on burnt ground.

ETYMOLOGY: developing early.

ANAMORPH: **Ascorhizoctonia praecox** Yang & Korf.

DISTRIBUTION: Europe, Greenland, India.

NOTES: This species is probably the most common among Tricharinas. It is always associated with burn sites, probably mostly of the first or second year, is usually cupulate and sunken in the substrate. See the notes below under var. **cretea** and especially those under var. **intermedia**.

LECTOTYPE: (designated here) P. A. Karsten #1176, in carbonario versus Haarankorpi, Tavastia australis, Tammela, Mustiala, 1.vi.1868 (H-Karsten).

LECTOPARATYPE: (designated here) P. A. Karsten #2501, in carbonariis, Tavastia australis, Tammela, Lektu, 22.vi.1868 (H-Karsten).

OTHER SPECIMENS EXAMINED:

CZECHOSLOVAKIA: V. Vácek, in carbonario, in silva mixta, Bohemia, 27/vi.1948 (PRM 178751); M. Svrček, in carbonario silv., Bohemia, 17.iv.1960 (PRM 620638); A. Vagner, on old burnt substrate, 17.6.1972 (PRM 731975); J. Kubička & M. Svrček, in carbonario, Chotycany, in valle rivi Libochovka, 13.7.1962 (PRM 568063); M. Svrček, in carbonario, Karlstejn, in piceto prope Boubova, 29.v.1965 (PRM 604126); M. Svrček, in carbonario, Bohemia, 7.VII.1970 (PRM 712293); M. Svrček, in carbonario, Cisarsky Les, 8.6.1950 (PRM 756476); J. Kubička & J. Moravec,in carbonario in silva, Bohemia, Karlstejn, 29.ix.1968 (CUP 61625 ex Herb. J. Moravec).

GREAT BRITAIN: W. D. Graddon, Sept. 1953 (K); collector unknown, on burnt substrate, Ranmore, Surrey, 24.5.1963 (K); R.W.G. Dennis, on burnt ground with **Anthracobia** and **Peziza**, Surrey, 22.5.1963 (K); D.A. Reid, on burnt ground, with **Anthracobia melaloma**, 2.6.1973 (K); M.C. Clark #2179, on bonfire and partly sunken, Earlswood, Warwicks., 6.5.1979 (K); B. Spooner, on burnt, sandy soil with **Anthracobia melaloma**, apothecia sunken in burnt sandy soil, 15.4.1984 (K).

GREENLAND: P.M. Petersen #72.B32, Holsteinsborg, Praestefjeld, Aug. 28, 1972 (C); P.M. Petersen #72.107, behind the arctic station on burnt place, Sept. 18, 1972 (C); P.M. Petersen #72,106, behind the arctic station on burnt place, Sept. 18, 1972 (C); P.M. Petersen #72.B33), Holsteinsborg, Praestefjeld, Aug. 28, 1972 (C); P.M. Petersen #72.92, behind the arctic station on fresh burnt site, Aug. 31, 1972 (C); P.M. Petersen #72.37, behind the arctic station on old burnt site among rocks, Aug. 2, 1972 (C); P.M. Petersen #72.B95), the valley E of Holsteinsborg. Aug. 27, 1972 (C).

INDIA: S.C. Kaushal, on ash and nearly burnt soil, Gulmarg, J&K, Aug. 28, 1972 (PAN 2480).

NORWAY: S. Sivertsen & H. Dissing #MO 79.56, on old burnt site, Nordland, Aug. 17, 1979 (C); H. Dissing & S. Sivertsen #SS 64-75, balplass, Ofv. Blerekelva, 7/9 1975 (TRH); S. Sivertsen, balplass, Vassbotndalen, vegenden, 16/8 1978 (TRH); H. Dissing & S. Sivertsen #79-63, pa balfflekk, 17/8 1979 (TRH).

SWEDEN: R. Morander #1117, burnt spot, Narke, 20.v.1948 (UPS); K. Starbäck #8, burnt substrate, Aug. 1895 (S).

SWITZERLAND: J. Webster #Sch 82.89, burnt place, no date (C).

TRICHARINA PRAECOX (Karst.) Dennis var. CRETEA (Cke.) Yang & Korf, **comb. nov.**

= **Peziza cretea** Cke., Trans. Bot. Soc. Edinburgh **13**: 46. 1877.
= **Lachnea cretea** (Cke.) Sacc., Syll. Fung. **8**: 184. 1889.
= **Scutellinia cretea** (Cke.) O. Kuntze, Rev. Gen. Pl. **2**: 869. 1891.
= **Tricharia cretea** (Cke.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
= **Tricharina cretea** (Cke.) Thind & Waraitch, Res. Bull. Punjab Univ., New Ser., Sci. **21**: 154. 1970.
= **Humaria vernalis** Vel., Monogr. Discomyc. Bohemiae 1: 328. 1934.

MISAPPLICATIONS:

Tricharina gilva (Boud. in Cke.) Eckbl. by Petersen, Friesia 10: 270-280. 1975 (pro parte); by Breitenbach und Kränzlin, Pilze Schw. 1: 90-91. 1981.

ILLUSTRATIONS:

Breitenbach und Kränzlin, Pilze der Schweiz 1: 91, fig. 71. 1981. (**Tricharina gilva**).
Cooke, Trans. Bot. Soc. Edinburgh **13**: pl. 3, fig. k-o. 1877. (**Peziza cretea**).
Cooke, Grevillea 6: pl. 97, fig. 4-7. 1877. (**Peziza cretea**).
Cooke, Mycographia pl. 100, fig. 362, 1878. (**Peziza cretea**).
Dennis, British Cup Fungi pl. VIB. 1960. (**Tricharia cretea**).
Dennis, British Ascomycetes pl. VIB. 1968 (**Tricharia cretea**).
Dennis, British Ascomycetes, ed. 2, pl. IXB. 1978. (**Tricharina cretea**).
Svrček, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 32B: pl. 6, fig. 9. 1979 (1976?). (**Tricharina praecox**).

Velenovský, Monogr. Discomyc. Bohem. 2: pl. 24, fig. 25. 1934. (**Humaria vernalis**).
This paper, figs. 2G; 6A, K; 16.

Differing from var. **praecox** by its whitish or yellowish hymenium, subfusoid ascospores with length to breadth ratios near 2.0 ± 0.1, the spores being narrower and slightly longer in this variety, 6.6–8.0 (–8.4) x 13.9–16.5 (–17.2) µm.

HABITAT AND SUBSTRATE: on plaster walls and ceiling in burnt house or in ash on burnt ground.

ETYMOLOGY: from the original substrate, plaster.

ANAMORPH: **Ascorhizoctonia cretea** Yang & Korf.

DISTRIBUTION: Europe, Greenland.

NOTES: Although the type specimen of **Humaria vernalis** Velen. was not included in the PRM loan sent to us, the illustrations made on it by Velenovský (1934) and by Svrček (1979) show that the fungus is assignable to **T. praecox** var. **cretea**. The spores are subfusoid with two rather conspicuous polar granules, and ornamented with fine, dispersed, cyanophilic dot-like markings. The spore length to breadth ratios, measured from their illustrations, is approximately 2.0. See also notes under **T. praecox** var. **intermedia**, below.

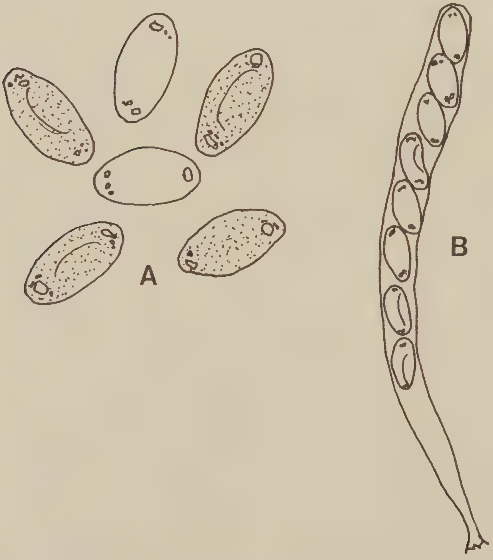


Fig. 16. **Tricharina praecox** var. **cretea** (from Kristiansen, 1982, S). A. Ascospores; note polar granules and randomly distributed dot-like warts on spore surface, X 1000. B. Ascus with 8 ascospores (X 500).

HOLOTYPE: collector unknown, on ceiling and plaster wall, Inverleith House, Edinburgh (K-Cooke).

OTHER SPECIMENS EXAMINED:

CZECHOSLOVAKIA: V. Vácek, in carbonario, Bohemia, 10.vii.1949 (PRM 178850); M. Svrček, in carbonario, Bohemia centr., 3.vii.1949 (PRM 756475); Z. Pouzar, in carbonario, Bohemia centr., 13.vi.1978 (PRM 818903).

DENMARK: P.M. Petersen, Jylland: Klosterhede Plantage, 15 km NW of Holstebro, 29.9.1968 (C); P.M.

Petersen, Jylland: Klostehede Plantage, on burnt over place, 29.9.1968 (C).

GREENLAND: P.M. Petersen #72.B94, the valley E of Holsteinsborg, Aug. 27, 1972 (C); P.M. Petersen #72.63, on burnt site, Godhavn, Lyngmarksbugten, Aug. 22, 1972 (C).

ITALY (?): G. Bresadola, ad terram limosam in carbonarius, Aug. 1897 (PC-Boudier).

NORWAY: S. Sivertsen & H. Dissing #MO 81.118, on burnt site, Nordland, Aug. 28, 1981 (C).

SWEDEN: R. Kristiansen, on fireplace along skilift, Jamtland, Undersaker, Mt. Valliste, 13.viii.1982 (S).

SWITZERLAND: F. Kränzlin #1104-77 BRL, on burnt and mossy ground, April 11, 1977 (in Herb. Natural History Museum of Lucern, Switzerland).

TRICHARINA PRAECOX (Karst.) Dennis var. **INTERMEDIA** Egger, Yang & Korf, **var. nov.**

MISAPPLICATION:

Tricharina gilva (Karst.) Dennis, by Tylutki, Mushrooms of Idaho and the Pacific Northwest: Discomycetes, p. 91. 1979.

ILLUSTRATIONS:

This paper, fig. 17.

Ab var. praecoxi ascosporis ad maturitatem sine ornamentatione cyanophilica differens.

Differing from var. **praecox** in usually lacking spore ornamentation, with pale orange to orange-tinted hymenia, spores 7.7-9.5 x 11.7-15.4 µm, rarely with delicate cyanophilic ornamentations on just mature spores, mature spores often collapsed, with a wrinkled, cyanophilic sheath, and differing from var. **cretea** in spore length to breadth ratios close to 1.5. The anamorphs of the three varieties also differ (Yang and Korf, 1985).

HABITAT AND SUBSTRATE: in ash on burn sites (usually of the first or second year).

ETYMOLOGY: intermediate between var. **praecox** and var. **cretea**.

ANAMORPH: **Ascorhizoctonia intermedia** Egger, Yang, & Korf.

DISTRIBUTION: North America.

HOLOTYPE: K.N. Egger #1132, on ash and burnt sandy soil in an old gravel pit, Christmas Lake, British Columbia, Canada, 8 May 1984 (DAOM); isotype, CUP 61648.

PARATYPE SPECIMENS EXAMINED:

CANADA: K.N. Egger #973, on fire site, Vancouver Island, B.C., 10 April 1983 (CUP 61642 ex Herb. K.N. Egger); K.N. Egger # 978, same data (CUP 61643 ex Herb. K.N. Egger); K.N. Egger #1118, on small slash burn at edge of conifer forest, south of Moyie, B.C., 6 May 1984 (CUP 61645 ex Herb. K.N. Egger); K.N. Egger #1119, same data (CUP 61646 ex Herb. K.N. Egger); K.N. Egger #1126, on burnt debris from slash burning in clearing-conifers, Christmas Lake, B.C., 8 May 1984 (CUP 61647 ex Herb. K.N. Egger); K.N. Egger #1106, on burnt soil and organic matter in a broad casted-burnt logged area (2100' elev.), Douglas fir and ponderosa pine, burned Fall 1983, 3 mi. N. of Nelson, B.C., at Redfish Creek Forest (CUP 61644 ex Herb. K.N. Egger).

U.S.A.: J.W. Paden #270 and E. Tylutki, on burned soil among moss, Jerome Creek, Latah County, [Idaho], Oct. 14, 1964 (ID).

NOTES ON THE THREE VARIETIES OF T. PRAECOX:

The ascospores, though considered to be eguttulate, have inclusions consisting of conspicuous polar granules. Paden (1968) considered what we term var. **intermedia** to be a fungus intermediate between **Trichophaea** and **Tricharia** because of the presence of these polar granules. In all three varieties the granule clusters usually consist of one large granule, 1.5 µm diam or slightly less, surrounded by many smaller granules (Fig. 6K).

The varieties are somewhat difficult to separate from one another. Because of its subfusoid spores with consistent ornamentations and narrow spore breadth, usually 8 µm or less, as well as consistently greater length to breadth ratio (nearly 2.0 rather than 1.5 in the other two varieties), var. **cretea** is rather easy to distinguish. Several specimens having both ellipsoid and subfusoid spores in the same apothecium were encountered, but these are placed in var. **praecox**.

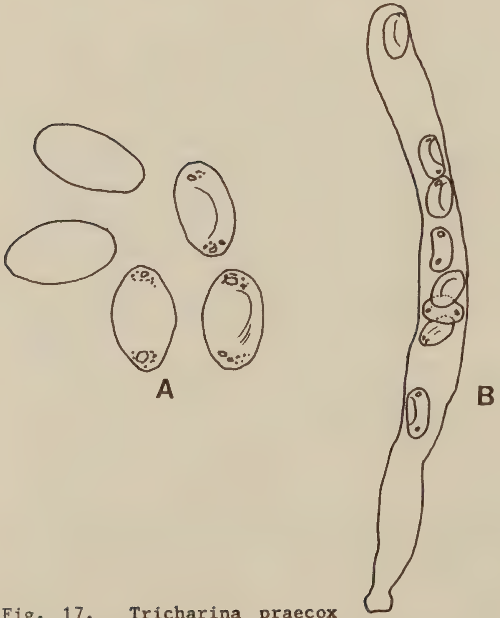


Fig. 17. **Tricharina praecox** var. **intermedia** (from the holotype). A. Ascospores; note smooth spore surface and polar granules, X 1000. B. Ascus with 8 ascospores, X 500.

The syntype specimens of var. **praecox** in Herb. Karsten (H) have ornamented spores, but we have come across several specimens collected in Greenland and in Norway assignable to var. **praecox** except for the spores having rather inconspicuous ornamentation. The anamorphs isolated from these specimens are virtually identical to those cultured from more typical specimens of var. **praecox**.

The new variety, var. **intermedia**, is based on North American specimens regularly having smooth, ellipsoid spores with a shape and spore length to breadth ratio similar to var. **praecox**. Cultures derived from these have growth rates and morphology intermediate between those of var. **praecox** and var. **cretea**. The mature and postmature, collapsed spores in these specimens, when stained with cotton blue 706, show the outermost, cyanophilic sheath forming wrinkles on the spore surface. One specimen has the maturing spores ornamented, but the markings disappear in mature and postmature spores. Because the differences between var. **praecox** and var. **intermedia** are rather subtle and could be confusing, the easiest criterion is probably their geographical origins, var. **intermedia** being North American and var. **praecox** being European, Indian, and from Greenland.

Among the three varieties, var. **praecox** is the most common, and var. **cretea**, with much the same geographical distribution, is rare. The most common in North America is probably var. **intermedia**.

Several North American specimens assignable to **Tricharina gilva** were collected from burnt substrates. Paden (1967) was able to recognize two taxa from specimens collected from burned soils. His **Tricharia gilva** fits our concept of **Tricharina gilva**, with discoid, larger apothecia. His second taxon, "**Tricharia** tax. sp. I," recognized here as **Tricharina praecox** var. **intermedia**, has deep cupulate, smaller apothecia. All **T. praecox** varieties have deep cupulate apothecia sunken into the burned substrates.

TRICHARINA STRIISPORA Rifai, Yang, & Korf, **sp. nov.**

ILLUSTRATIONS:
This paper, fig. 18.

An speciebus aliis Tricharinae ascosporarum ornamentationibus constantibus ex punctis cyanophilicis in striis longitudinalibus dispositis differens.

Apothecia small, drying 3-4 mm broad, cupulate, externally brownish; **hymenium** drying grayish orange, 170-200 µm thick; **hairs** marginal, fasciculate, flexuous, up to 310 µm long, 11.0-13.0 (-15.0) µm broad at base, with brown, 1.5-2.0 µm thick walls, 4-6 septate, accompanied by brownish, thick-walled cells; **excipulum** two-layered, ental layer of textura intricata, thicker than the ectal layer, ectal layer of textura globulosa composed of 3-5 cell layers of inflated, brownish-walled cells 18.7-22.4 x 28.0-31.7 µm, with wall 1.0-1.5 µm thick; **asci** cylindrical, narrowing toward base, 8-spored, 10.0-12.0 x 170-190 µm, J-; **ascospores** ellipsoid, uniseriate, hyaline or yellow-refractive when mature and mounted in lactic-acid containing media, ornamented with longitudinal stripes of cyanophilic, dot-like warts, eggutulate but with some polar granules, 7.5-9.2 x (14.6-) 15.8-17.6 (-19.0) µm; **paraphyses** slender, septate, 2.5-3.5 µm broad, slightly enlarged near apex to 3.5-4.0 µm.

HABITAT AND SUBSTRATE: on soil.

ETYMOLOGY: ornamentations in stripes on the spore surface.

ANAMORPH: unknown.

DISTRIBUTION: known only from the type locality.

NOTES: The spore ornamentation in longitudinal stripes is wholly different from any other species of **Tricharina**. This specimen was first examined by M.A. Rifai, who labelled the packet with the

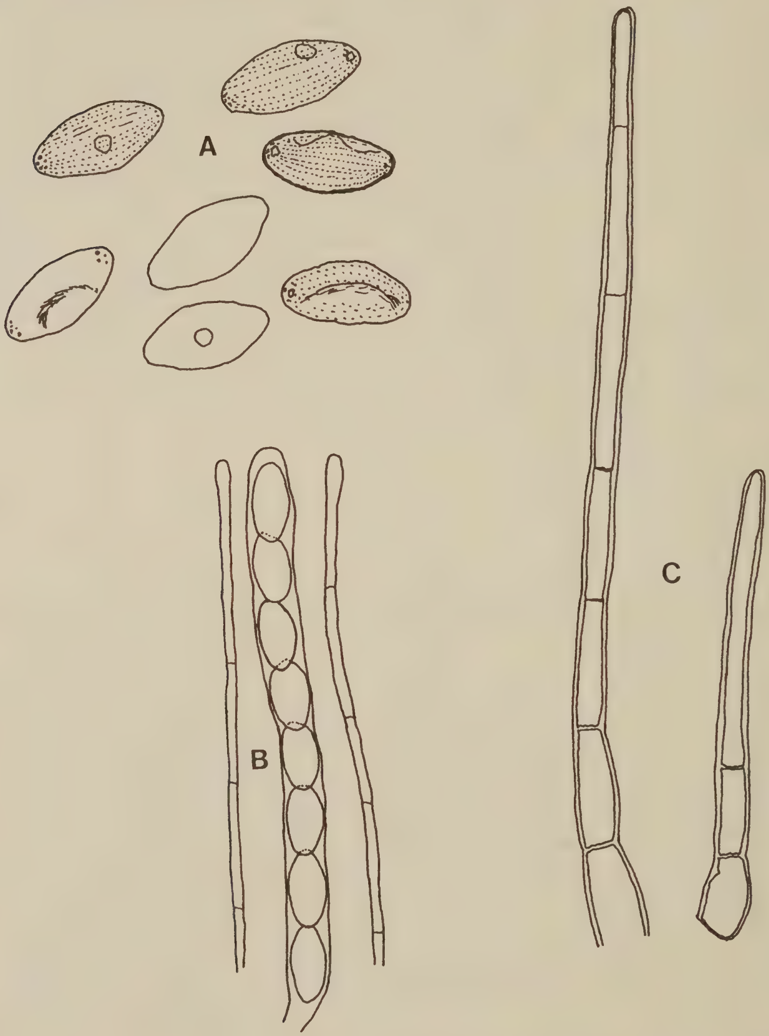


Fig. 18. **Tricharina striispora** (from the holotype). A. Ascospores; note longitudinal stripes of cyanophilic dot-like warts on spore surface. B. Ascus with 8 ascospores, two paraphyses, X 500. C. Marginal hairs, X 500.

epithet "**striispora**," but decided not to publish it, indicating in his annotation, "not sufficient apothecia for a type specimen." The collection at Kew has 3 or 4 apothecia in different stages of development in relatively good shape. Because we are able to use a small piece of an apothecium and make many sections with a freezing microtome, we decided to publish it as new here, retaining Rifai's epithet. Additional sections not used in our preparation of the microscopic portions of our description were dried on a microslide and returned to the original herbarium packet.

HOLOTYPE: on ground, from Beaumont, South Australia, leg. J.B. Cleland, 18 May 1920 (K).

GENERIC DESCRIPTION OF WILCOXINA GEN. NOV.

WILCOXINA Yang & Korf, **gen. nov.**

*Ab **Tricharina** excipulo ectali non distincte bistrato, ascosporis dimidium superius asci maturi tantum occupantibus, et procreatione anamorphosis lente crescentis generis **Complexipedis** et non celeriter crescentis generis **Ascorhizoctoniae** distinguenda.*

Apothecia small, cupulate, expanding to discoid, sessile, attached only at the center, scattered or gregarious; **hymenium** whitish to yellowish orange, senescing to brownish gray; **hairs** both marginal and running down the flanks, fasciculate, with large clusters near margin and clusters gradually becoming smaller towards the base of the apothecium, pale brown to brown, with narrow bases arising from a chain of thick-walled excipular cells, the broadest part of the hair well above the point of origin of the hair, containing brownish, globose inclusions often appearing attached to the walls, walls 2.0-4.0 µm thick, with thin or thick septa; **excipulum** clearly two-layered near the margin, ental layer becoming broader toward the apothecial base, of textura intricata, in some taxa having refractive, thick-walled hyphae threading horizontally through the layer, ectal layer of textura globulosa to textura angularis, composed of some almost globose to radially elongated cells with pale brown to brown, thick walls becoming mixed near the apothecial base with some small-diameter hyphae from the ental layer; **asci** cylindrical, narrowing toward base, apically operculate, 8-spored or rarely (2-) 4 (-6)-spored, J-; **ascospores** ellipsoid, uniseriate, lining up in the upper half of the ascus, smooth, hyaline or refractive-yellow when mature and mounted in media containing lactic acid, eguttulate, but often with a few small granules or with small, polar clusters of fine granules; **paraphyses** slender, septate, branched near base, with or without carotenoid particles, slightly enlarged toward apex.

HOLOTYPE: **Wilcoxina mikolae** (Yang & Wilcox) Yang & Korf (= **Tricharina mikolae** Yang & Wilcox).

ANAMORPHS: **Complexipes** Walker emend. Yang & Korf ("E-strain" fungi).

ETYMOLOGY: Named after Professor Hugh E. Wilcox, SUNY College of Environmental Science & Forestry at Syracuse University, whose persistence led to the discovery of two taxa belonging to this genus and to the holomorphic associations; his contribution to the study of E-strain fungi is unrivalled.

HABITAT AND SUBSTRATES: on soils, coniferous litter, or on soil under pines, forming ectomycorrhizae or ectendomycorrhizae with members of the Pinaceae, rarely on decayed logs.

NOTES: This genus differs from **Tricharina** in hair structure, excipular organization, spore arrangement within asci, mode of ascospore germination, type of anamorph produced, and mycorrhizal formation. The thick-walled excipular cells revive well in dried specimens, unlike those of **Tricharina** spp. which often remain collapsed even after long rehydration in water or 2% KOH. The characteristic chlamydospores often produced in cultures and in soil are found worldwide; the apothecia have rarely been collected, and probably are seldom produced in nature.

DESCRIPTIONS OF ACCEPTED TAXA IN WILCOXINA

WILCOXINA ALASKANA Kempton, Yang, & Korf, **sp. nov.**

ILLUSTRATIONS:
This paper, fig. 19.

*Ab **W.** mikolae pilis longis (300-550 µm) flexuosis tenuibus differens.*

Apothecia small, 6-12 mm diam, cupulate, expanding to discoid, sessile; **hymenium** ochraceous, 290-340 µm thick; **subhymenium** 50-70 µm thick; **hairs** marginal and on flanks downward to the apothecial base, hyaline to pale brown, slender, flexuous, septate, fasciculate, mostly 300-400 (-550) µm long, 4.6-6.0 µm broad, slightly narrowing towards both ends, arising from the outermost layer of the excipulum, becoming frequently septate near base and merging into basal cells in a chain, tapering to a rounded apex, cells frequently containing spherical inclusions, walls 2.0-2.5 µm thick; **excipulum** mostly 500-600 (-1000) µm thick, ental layer up to 900 µm thick near apothecial base, of textura intricata consisting of hyaline, filamentous, narrow hyphae 3.5-6.0 µm broad, becoming inflated, thicker-walled toward margin, ectal layer of textura globulosa to textura angularis, 50-75 (-100) µm thick, cells 12-16 x 18-22 µm, hyaline to brownish, mixed with some small-diameter hyphae from the ental layer; **asci** cylindrical, 8-spored, 8.0-11.0 (-12.3) x 250-350 µm, J-; **ascospores** ellipsoid, uniseriate, occupying the upper half of the ascus, smooth, outermost layer cyanophilic, eguttulate but containing a small cluster of granules at each pole, refractive-yellow at maturity when mounted in media containing lactic acid, 7.0-8.4 (-9.5) x 12.0-15.0 (-16.1) µm; **paraphyses** slender, septate, branched near base, containing carotenoid particles, 1.5-2.0 µm broad, slightly enlarged near apex to 2.5 µm broad.

HABITAT AND SUBSTRATE: on decayed, mossy log.

ETYMOLOGY: from the state where the fungus was collected.

ANAMORPH: unknown.

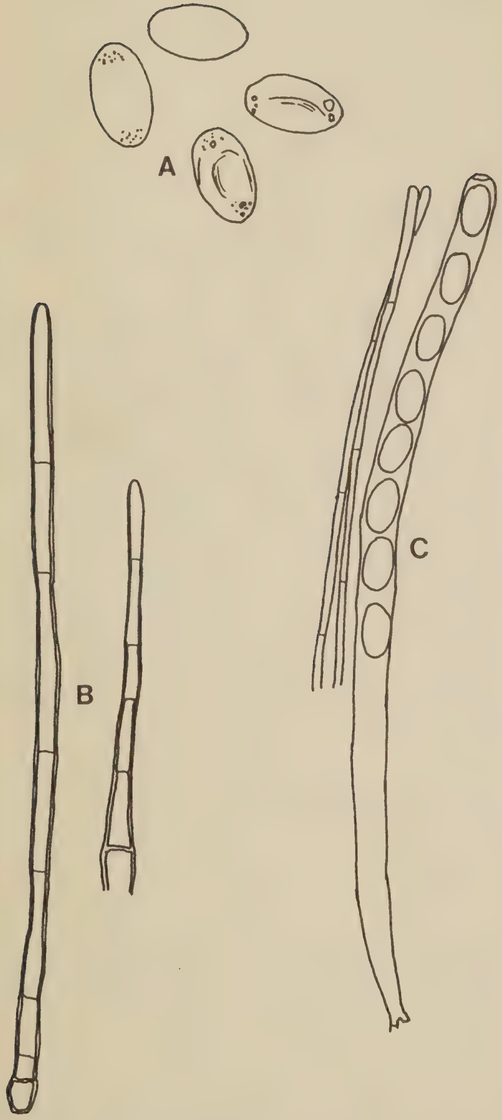


Fig. 19. **Wilcoxina alaskana** (from the holotype). A. Ascospores; note small clusters of polar granules in mature spores, X 1000. B. Marginal hairs, X 500. C. Ascus with 8 ascospores, two paraphyses, X 500.

DISTRIBUTION: known only from one area in Alaska.

NOTES: Long, slender, flexuous hairs and the thick excipulum make this easily recognizable among Wilcoxinas, as does the thick subhymenium. No cultures were obtained from ascospores in revival trials. Growth on a log is unusual in this genus. The collector, P. E. Kempton, took excellent field data and made critical microscopic observations which are combined with ours in the description. In one paratype collection (CUP 61738) we saw no mature ascospores.

HOLOTYPE: on decayed, mossy log, Butte, Palmer Highway, Alaska, leg. Phyllis E. Kempton, 6-5-1963 (NY), isotypes: CUP 61695; Wells-Kempton Herbarium, Anchorage, Alaska 6-5-33 #4.

PARATYPES EXAMINED: P. E. Kempton 3078, Butte area, W. side, southcentral Alaska, growing gregariously on moss-covered, rotting, cottonwood log, 6/1/64 (CUP 61737), isoparatypes: MICH; Wells-Kempton Herbarium, Anchorage, Alaska 3078. P.E. Kempton 3079, Butte area, W. side, southcentral Alaska, gregarious on moss-covered cottonwood log, 5/25/64 (CUP 61738), isoparatypes: MICH; Wells-Kempton Herbarium, Anchorage, Alaska 3079.

WILCOXINA MIKOLAE (Yang & Wilcox) Yang & Korf, **comb. nov.**, var. **MIKOLAE**
= **Tricharina mikolae** Yang & Wilcox, Mycologia **76**: 678. 1984.

MISAPPLICATION:
Tricharina gilva (Boud. in Cke.) Eckbl., by van Brummelen, Cryptog. Mycol. 4: 165-171. 1983.

ILLUSTRATIONS:
van Brummelen, Cryptog. Mycol. 4: 168-169, figs. 1-2. 1983. (**Tricharina gilva**).
Yang and Wilcox, Mycologia **76**: 677, figs. 1-5; 679, figs. 6-7. (**Tricharina mikolae**).
This paper, fig. 20.

Apothecia 1-8 mm broad, scattered or gregarious, sessile, centrally attached, hemispherical becoming discoid; **hymenium** whitish to orange yellow to brownish gray, 160-210 µm thick; **hairs** marginal and on flanks extending to apothecial base, subhyaline to pale brown, smooth, septate, 100-300 µm long, 9.0-13.1 µm wide, arising from basal cells in chains, apices rounded to pointed, walls 1.0-2.0 µm thick, cells with spherical inclusions; **excipulum** two-layered, becoming less distinctive towards base, ental layer of textura intricata, becoming thicker towards base, with refractive, thick-walled vessels threading horizontally in the upper part of the ental layer, ectal layer of textura globulosa, becoming mixed with some small-diameter hyphae; **asci** cylindrical, narrow towards the base, 8-spored, 9.0-11.0 x 160-200 µm, J-; **ascospores** ellipsoid, uniseriate, occupying the upper half of the ascus, smooth, eguttulate but with a few, polar granules, hyaline or refractive-yellow when mature and mounted in lactic acid-containing media, outermost sheath cyanophilic, 6.0-9.0 x 11.0-14.0 µm; **paraphyses** slender, septate, containing carotenoid particles, 2.0-2.5 x 120-160 (-180) µm, slightly enlarged at the tip to 3.0-4.0 µm.

HABITAT AND SUBSTRATE: In pot culture of red pine seedlings forming ectendomycorrhizae (Yang & Wilcox, **1984**) and on soil in a 3-year-old burn site (van Brummelen, **1983**).

ETYMOLOGY: honoring Pietsa Mikola, discoverer of E-strain mycorrhizal fungi.

ANAMORPH: **Complexipes** sp.; a dried culture (C.S.Y. 14) derived from the type specimen of the discomycete has been deposited as CUP 61636; two others derived from the Netherlands' collection, CUP 60689, are also deposited (C.S.Y 91 as CUP 61637; C.S.Y. 92 as CUP 61638).

DISTRIBUTION: North America, Europe.

NOTES: A polyspore-isolate, C.S.Y 14-ps, derived from the holotype, produced apothecia in large quantities for two years when grown with red pine seedlings in flask culture for mycorrhizal synthesis. A single-spore-isolate, C.S.Y. 19-ss, produced some infertile ascocarps under similar cultural conditions. Another polyspore isolate, C.S.Y. 91-ps, derived from the Netherlands' collection, CUP 60689, also produced ectendomycorrhizae with red pine seedlings in axenic culture.

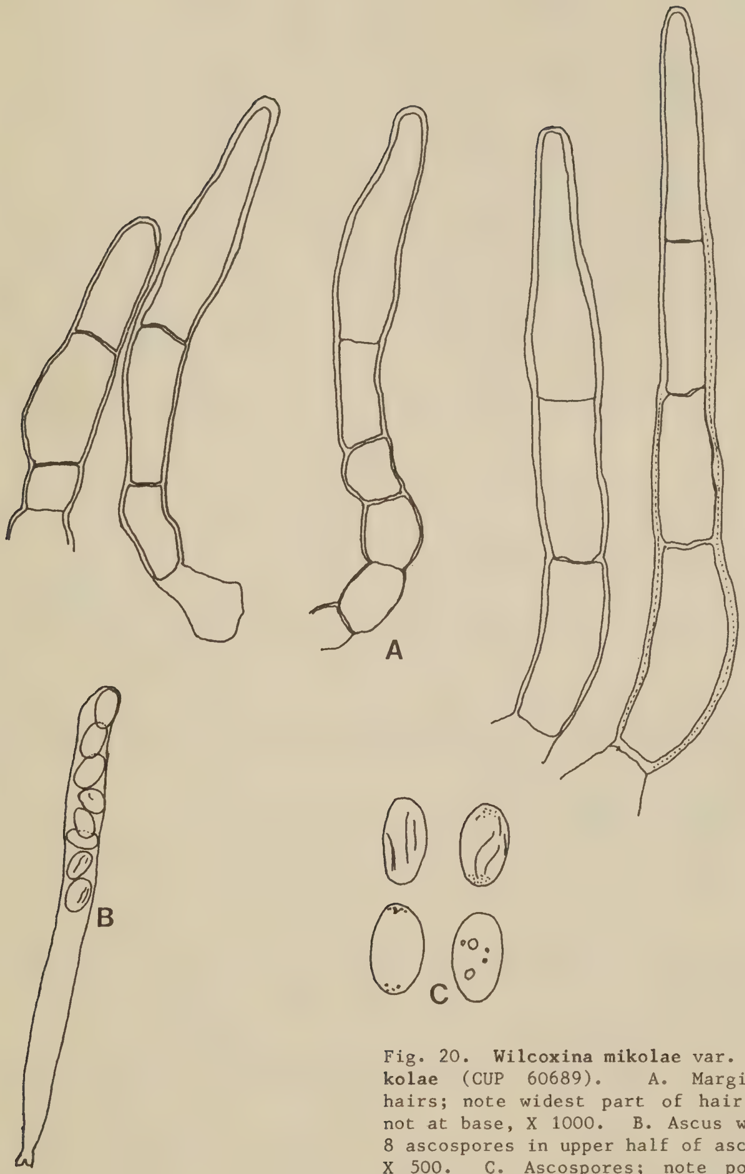


Fig. 20. **Wilcoxina mikolae var. mikolae** (CUP 60689). A. Marginal hairs; note widest part of hair is not at base, X 1000. B. Ascus with 8 ascospores in upper half of ascus, X 500. C. Ascospores; note polar granules and collapse of postmature spores, X 1000.

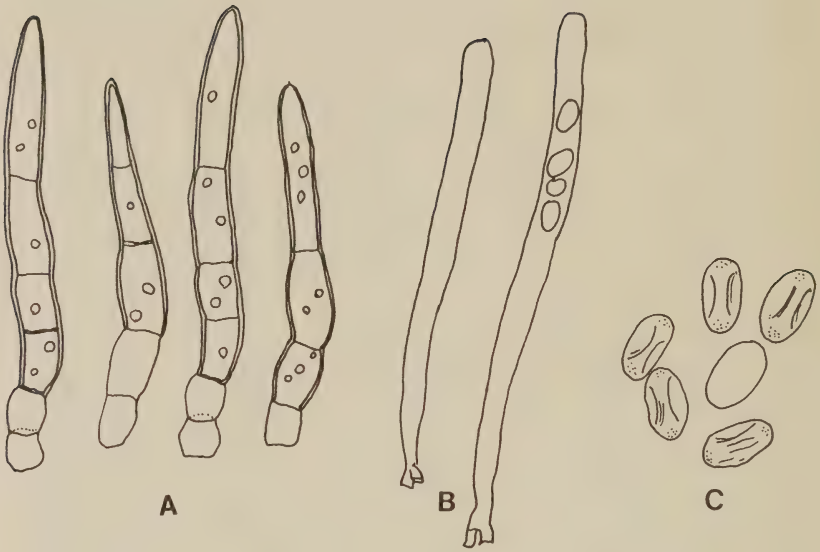


Fig. 21. **Wilcoxina mikolae** var. **tetraspora** (from the holotype). A. Marginal hairs; note small, globular inclusions in hairs, X 500. B. Asci; note four mature scospores, the other four disintegrated, in mature ascus, and a young ascus, X 500. C. Mature and postmature ascospores; note polar granules in collapsed spores, X 1000.

HOLOTYPE: C.S. Yang & H.E. Wilcox, in soil on pot culture of red pine seedlings in greenhouse, SUNY-College of Forestry, Oct. 1982 (BPI 71929); isotypes: BPI 71930, CUP 59892, DAOM, FH, FLAS, IMI 281167, K, NY, OSC, SYRF.

OTHER COLLECTION EXAMINED:
G. Piependroek-Groters #1284, on three year old burnt ground amongst mosses, near Gietlo, between Wilp and Klarenbeck, Prov. Gelderland, the Netherlands, 2.x.1982 (CUP 60689 ex L).

WILCOXINA MIKOLAE (Yang & Wilcox) Yang & Korf var. **TETRASPORA** Wilcox, Yang, & Korf, **var. nov.**

ILLUSTRATIONS:
This paper, fig. 21.

Ab var. ***mikolae*** *sporis quaternis et ascosporis brevioribus angustioribusque differens.*

Apothecia small, 2-8 mm broad, sessile, cupulate, expanding to shallow cupulate, then discoid, margin occasionally split as apothecium expands; **hymenium** whitish to pale orange, senescing to grayish brown, 160-186 μm thick; **hairs** marginal and on flanks to the apothecial base, fasciculate, clusters large near margin and gradually decreasing to smaller clusters of only a few hairs near base, 5.6-13.1 x 85-150 µm, arising from basal cells in chains, blunt and tapering to rounded apices, with globular inclusions, wall 1.0-1.5 (-2.2) µm thick; **excipulum** clearly two-layered near margin, becoming thicker and up to 400 µm thick toward apothecial base, ental layer of textura intricata, but also containing thick-walled, horizontally threading vessels; ectal excipulum of textura globulosa to textura angularis, 40-150 µm thick, of 3-7 cell layers of hyaline to pale brown, thick-walled, inflated cells mixed with some small-diameter hyphae; **asci** cylindrical, narrow near base, initially cutting out 8 ascospores but only (2-) 4 (-6) spores maturing, 9.3-11.2 x 130-150 µm, J-; **ascospores** ellipsoid, uniseriate, lining up in the upper half of the ascus, smooth, eguttulate with polar granules, hyaline or refractive-yellow when mature and mounted in lactic acid-containing media, outermost sheath cyanophilic, 5.9-7.0 x 9.5-11.2 (-11.7) µm; **paraphyses** slender, septate, branched near base, 2.0-2.5 µm broad, occasionally enlarged to 2.5-4.5 µm near apex.

HABITAT AND SUBSTRATE: on soil in greenhouse pot cultures of red pine seedlings and in seedbeds of coniferous seedlings.

ETYMOLOGY: from the predominantly tetrasporous asci.

ANAMORPH: **Complexipes** sp., a dried culture (C.S.Y. 57, derived from the holotype of the discomycete) has been deposited as CUP 61639.

DISTRIBUTION: New York.

NOTES: The major distinguishing features from var. **mikolae** are the smaller spores and mostly four-spored asci.

HOLOTYPE: C.S. Yang, in soil near red pine seedlings in greenhouse at SUNY-College of Forestry, Syracuse, NY, soil from Pack Forest, Warrensburgh, NY, 7-14-1984 (CUP 60628).

PARATYPE: H. E. Wilcox, on soil under red pine seedlings, Lafayette Experimental Station, SUNY-College of Forestry, Lafayette, NY, 10-3-1983 (CUP 59893).

WILCOXINA REHMII Yang & Korf, **sp. nov.**

MISAPPLICATIONS:
- **Humaria gilva** (Boud. in Cke.) Sydow, by Sydow, Mycoth. march. # 775. 1884.
- **Humaria melaloma** (Alb. & Schw. : Fr.) Kanouse, by Kanouse, Mycologia **39**: 656. 1947.
- **Lachnea gilva** (Boud. in Cke.) Rehm, by Rehm in Rabenh., Krypt.-Fl. ed. 2 **1**(3)[Lief 44]: 1049. 1895.

ILLUSTRATIONS:
This paper, figs. 4A,B; 21.

EXSICCATAE:
Sydow, Mycotheca marchica #775. 1884. (**Humaria gilva**).

*Ab speceibus alliis **Wilcoxinae** et **Tricharinae** pilis atrobrunneis parietes crassos possidentibus differens.*

Apothecia small, 1-3 mm broad, sessile, terrestrial, cupulate to shallow cupulate, centrally attached, exterior dark brown; **hymenium** whitish to orange-tinted (rehydrated), 180-250 (-300) µm thick; **hairs** marginal and extending down the flanks to the apothecial base, in large clusters near margin, fascicles gradually becoming reduced to a few hairs towards base, stiff, brown to dark brown, slightly curved towards the hymenium or straight, thick-walled (wall 2.0-4.0 µm thick), often with yellowish-brown globular inclusions in hairs sometimes attached to inner wall surface, narrowing toward base and becoming frequently septate, arising from a chain of brown, thick-walled cells, 150-220 (-440) µm long, 9.0-13.1 (-15.0) µm broad, with rounded to pointed apices, septa thin to thick, septal plate with obvious septal pore and up to 1.5 µm thick; **excipulum** thick, clearly two-layered near margin and along flanks, becoming thicker toward base, with ectal layer becoming mixed with some small-diameter hyphae near base, ental layer of textura intricata, up to 300 µm thick, indistinguishable from the subhymenium, ectal layer of textura globulosa to textura angularis, 50-70 µm thick near margin and 70-110 µm thick near base, composed of 3-7 cell layers of brown-walled cells 15.0-22.0 x 16.0-28.0 µm with walls 1.0-2.0 µm thick; **asci** cylindrical, narrowed toward base, 8-spored or rarely 4-6-spored, J-, wall up to 1.0 µm thick, 9.0-12.4 (-13.1) x 170-220 mm; **ascospores** ellipsoid, uniseriate, occupying the upper half of the ascus, eguttulate but with polar granules, smooth, hyaline or yellow-refractive when mature and mounted in lactic acid-containing media, outermost sheath cyanophilic, 7.0-8.8 x (11.7-) 12.8-15.4 (-16.1) µm; **paraphyses** slender, septate, branched near base, 1.0-2.0 µm broad, equal or slightly enlarged near apex to 2.0-3.5 µm.

HABITAT AND SUBSTRATE: on soils, coniferous litter, mycorrhizal with pinaceous conifers.

ETYMOLOGY: After H. Rehm (1828-1916), the German mycologist.

ANAMORPH: **Complexipes** sp. ("E-strain" fungi). Dried cultures (C.S.Y. 85-ps ex TRH 19-9-1974; C.S.Y. 100-ps ex CUP-MM 1421) have been deposited as CUP 61640 and 61641, respectively.

DISTRIBUTION: probably widely distributed in temperate regions; known from Europe, Canary Islands, and North America.

NOTES: This fungus is the most common species in the genus **Wilcoxina**, and probably fruits on the same site for more than one season. We have examined several collections with identical or similar site data that were apparently collected in 2 or 3 consecutive years. It is rather easily distinguishable by its dark brown, thick-walled hairs from other species of **Wilcoxina** and of **Tricharina**. The earliest known record of this is a collection from 1883 by Bresadola, assigned by Rehm (1895) to **Lachnea gilva**.

HOLOTYPE: Sydow, Mycoth. march #775 as **Humaria gilva**, An einer Grabenbosihung im Schlaihsensee in Grunewald bei Berlin, Juli 1885, leg. P. Sydow (S-Sydow); we have examined several isotypes at K, NY, S-Rehm.

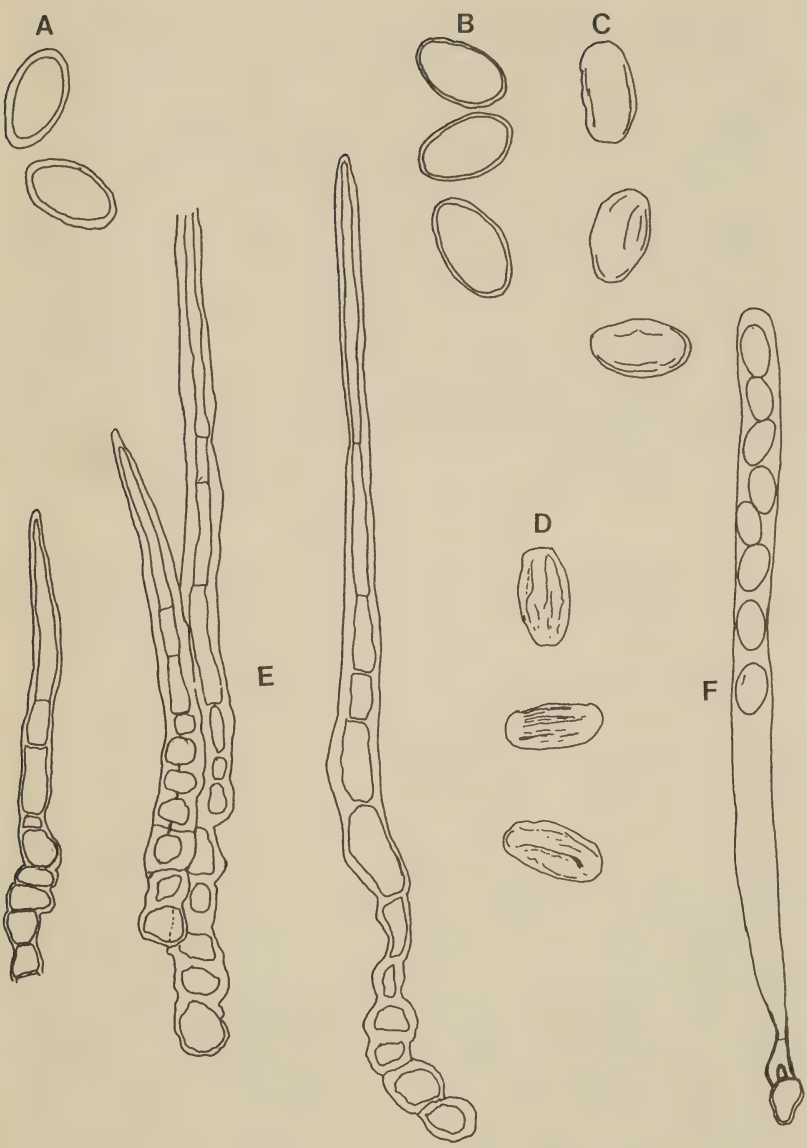


Fig. 22. **Wilcoxina rehmii** (TRH 72-9, A-D X 1000, E-F X 500). A. Young, immature ascospores. B. Almost mature ascospores. C. Mature ascospores. D. Postmature ascospores with collapsed walls. E. Marginal hairs with thick walls and brown, spherical inclusions. F. Ascus with 8 ascospores in upper half of ascus.

PARATYPE SPECIMENS EXAMINED:

CANARY ISLANDS (SPAIN): R.P. Korf, R. Fogel, G.L. Hennebert, and L.M. Kohn, on soil under pines, Hierro, Jan. 8, 1977 (CUP-MM 1421).

FRANCE: F. Candoussau, Vallée de Lesponne près Bagneres de Bogorre, Le Chiroulet 65, 20.viii. 1972 (Herb. R.P. Korf #4228); F. Candoussau, no data, 1973 (Herb. R.P. Korf #4135).

GERMANY: P. Sydow, an einem Grabenrand im Grunewald bei Berlin, 7.1885 (S-Rehm) [probable isotype].

ITALY: A.G. Bresadola, in sylvis tridentis ..., Sudtyrol, 1883 (S-Rehm); A.G. Bresadola, in silva ..., Julio 1883 (S-Bresadola) [these two specimens are clearly parts of one collection].

NORWAY: S. Sivertsen and H. Dissing #72-7, pa jord, Nordl.: Rana, 5/9 1972 (TRH); S. Sivertsen and H. Dissing #72-9, pa jord, Nordl.: Rana, 5/9 1972 (TRH); S. Sivertsen and H. Dissing, pa jord, Nordl.: Rana, 3/9 1973 (TRH); A. Erlandsen #74-9, dyresti pa leirjord, 29/7 1974 (TRH); S. Sivertsen, in solo arenoso, 19/9 1974 (TRH); H. Dissing and S. Sivertsen, pa jord, 9-9-1975 (TRH).

U.S.A.: A. H. Smith #14748, on soil, Elhwa River, Washington, July 7, 1939 (MICH).

SIX EXCLUDED SPECIES

In addition to the many lichens assigned to **Tricharia** Fée, the following discomycete species must be excluded from **Tricharina** and from **Wilcoxina**:

1. TRICHARINA BISETOSA Thind & Kaushal, Indian J. Mycol. Plant Pathol. **9**: 229. 1979.

HOLOTYPE: on decaying twig, Narkanda, H.P., India, leg. S.C. Kaushal, Aug. 17, 1971 (PAN 2408); isotype CUP 61633.

PARATYPE SPECIMEN EXAMINED: on decaying twigs, Baghi, H.P., India, S.C. Kaushal, Sept. 10, 1971 (PAN 2434).

NOTES: This species, described from India, is characterized by two types of hairs arising 2-4 cell layers deep in the ectal excipulum (Thind and Kaushal, **1979**). The hairs of this species are single, not fasciculate, and partially rooting. The eguttulate ascospores are yellow-refractive when mounted in lactic acid, but our KOH-treatment of the ascospores faied to remove the yellow color, as would occur in **Tricharina** and in **Wilcoxina**. We conclude the species is better placed in **Cheilymenia** than in **Tricharina**. A question was recently raised by Moravec (**1984**) about the generic concept in **Cheilymenia**, and he suggested removing C. **theleboloides** (Alb. & Schw. : Fr.) Boud. and its allies, with superficial hairs, to **Coprobia**. **Cheilymenia** in its restricted sense would thus have an excipulum of the C. **coprinaria** (Cke.) Boud.-type with deep-rooting hairs (Denison, **1964**). The hairs found in **T. bisetosa** fall somewhere between these two groups. The substrate for this species is a decaying twig, not a usual substrate for any **Tricharina**. We thus propose:

CHEILYMENIA BISETOSA (Thind & Kaushal) Yang & Korf, **comb. nov.** (basionym: **Tricharina bisetosa** Thind & Kaushal, Indian J. Mycol. Plant Pathol. **9**: 229. 1979).

2. TRICHARIA EICHLERI (Bres.) Boud. (as "Echlerii"), Hist. Classif. Discomyc. Europe p. 57. 1907.
   = **Lachnea eichleri** Bres. (as "Eichlerii"), Ann. Mycol. 1: 119. 1903.
= **Ciliaria (Trichophaea) bicuspis** Boud., Bull. Soc. Mycol. France 12: 11. 1896.
   = **Trichophaeopsis bicuspis** (Boud.) Korf & Erb, Phytologia 24: 18. 1972.

NOTES: The type specimen was examined by Korf and Erb (1972), where a complete synonymy is given, and Bresadola's name was synonymized with **Trichophaeopsis bicuspis**. That disposition is accepted here.

3. TRICHARINA MARIAE (Svrček) Svrček, Česká Mykol. 35: 85. 1981.
   = **Lachnea mariae** Svrček, Stud. Bot. Čech. 9: 137. 1948.

NOTES: The curators at PRM were unable to locate the type specimen. From the description and published drawings (Svrček 1948, 1949), we cannot decide whether it is a **Tricharina** or not. No Tricharinas have been found on a similar substrate (subaquatic, dead branches of **Larix europea**), and we exclude it from the genus until the type can be relocated and restudied.

4. TRICHARIA OLIVASCENS (Cooke) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
   = **Peziza scutellata** L. [var.?] B **macrochaeta** De Not., Comm. Soc. Crittog. Ital. 1: 387. 1964.
   = **Peziza macrochaeta** (De Not.) Rabenh. in Gonnerm. & Rabenh., Mycol. Eur. 3: pl. 5, f. 4. 1870 (later homonym, non **P. macrochaeta** Fries 1851).
   = **Peziza olivascens** Cooke, Grevillea 3: 74. 1874 [avowed substitute for **P. macrochaeta** (De. Not.) Rabenh. non Fries].
   = **Scutellinia olivascens** (Cooke) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.

ISOTYPE EXAMINED: Erb. Critt. Ital. #585 as **Peziza scutellata** B **macrochaeta** (K-Cooke).

NOTES: A piece of the isotype specimen and drawings of part of a hair, paraphyses, and ornamented and smooth ascospores enclosed in that herbarium packet were examined. The hairs are single, up to 1000 mm long, rooting and forked at the base, ascospores broadly ellipsoid to subglobose, ornamented with cyanophilic warts, multiguttulate, and without yellow-refractive color in lactic acid mounts. The fungus is surely a **Scutellinia**, possibly **Scutellinia umbrarum** (Fr.) Lamb. The epithet "macrochaeta" would be available in either **Tricharia** or in **Tricharina**, but not in **Scutellinia**.

5. TRICHARINA SUBGLOBISPORA Svrček, Česká Mykol. 28: 136. 1974.

HOLOTYPE: Austria, Sonntagberg, ad terram nudam deustam, viii.1908, leg. P. Strasser (G-GK 12509); isotype in W (not examined by us).

NOTES: When Svrček (1974) described this fungus from a 1908 collection, he stressed as a key character its sphaerically-ellipsoid ascospores, certainly unusual in **Tricharina**. The type material consists of two distinct discomycetes, **Sphaerosporella brunnea** (Alb. & Schw. : Fr.) Svrček & Kubička and **Trichophaea woolhopeia** (Cooke in Phill.) Boud., and burnt substrate. Both of these common fungi are associated with burn sites. **S. brunnea** has globose, guttulate ascospores, and is clearly not the fungus described by Svrček. **T. woolhopeia** has broadly ellipsoid ascospores with one large guttule (Dennis, 1968). Young, immature ascospores of the portion we identify as **T. woolhopeia** stain blue in cotton blue-lactic acid, while mature ones usually contain one deBary bubble and do not take up the blue dye, nor show a yellow-refractive color as all Tricharinas do. Apparently Svrček did not see mature ascospores or overlooked the oil droplet in such spores. We select here the **Trichophaea woolhopeia** portion of the holotype in G as LECTOTYPE of Svrček's species, and place his name in synonymy with it.

6. TRICHARINA VELENOVSKYI (Vacek in Svrček) Svrček, Česká Mykol. 35: 86. 1981.
   = **Lachnea velenovskyi** Vacek in Svrček (as "Velenovskýi"), Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 4(6): 51. 1949.
   = **Humaria velenovskyi** (Vacek in Svrček) Korf & Sagara, Phytologia 24: 4. 1972.

SPECIMEN EXAMINED: F. Candoussau #530, sur **Picea**, avec **Antinoa acuum** Vel., dans les aigulles de **Picea**, endroit très humide, Bois de Baraibar, San Sebastien, Espagne (Spain), 27.x.1973 (Herb. R.P. Korf 4234).

NOTES: The curators at PRM were unable to locate the type specimen. From the description and drawings given by Svrček (1949), the description and micrographs of Korf and Sagara (1972), and the examination of the specimen cited above, we conclude that the fungus does not belong in **Tricharina** by virtue of its densely ornamented, biguttulate ascospores and non-fasciculate hairs. All these features were noted by Svrček (1948), and we do not understand why, without comment, Svrček (1981) transferred it to **Tricharina**. The fungus is certainly better placed in **Humaria** Fckl. sensu stricto (= **Mycolachnea** Maire).

DOUBTFUL SPECIES

Although Boudier (1907) accepted 20 species in **Tricharia**, only five of these names are retained here in **Tricharina** as accepted species or varieties. **Tricharia cinerella** and **T. fimbriata** are considered to be synonyms of **Tricharina gilva**. Two species, **Tricharia eichleri** and **T. olivascens**, are excluded from **Tricharina** (see above). The remaining eleven epithets are listed below as doubtful species:

1. TRICHARIA ALBOBADIA (Saut.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
   = **Peziza albobadia** Saut., Flora 28: 133. 1845.
   = **Humaria albobadia** (Saut.) Poetsch & Schiederm., Syst. Aufz. Krypt. p. 161. 1872.

= **Lachnea albobadia** (Saut.) Sacc. (as '**Lachnea alboflava**'), Syll. Fung. **8**: 186. 1889; Rehm in Rabenh., Krypt.-Fl., ed. 2, 1(3)[Lief. 44]: 1066. 1895; corr. Rehm in Rabenh., Krypt.-Fl., ed. 2, 1(3)[Lief. 44]: 1050, 1068. 1895.
= **Scutellinia albobadia** (Saut.) O. Kuntze (as '**Scutellinia alboflava**'), Rev. Gen. Pl. **2**: 869. 1891.
= [**Peziza alboflava** Saut. in Keissler, Ann. K.K. Naturhist. Hofmus. **31**: 85. 1917, nom. nud., corr.]

The type specimen was revised by Keissler (**1917**) who thought this to be either a good species or a variety of **Trichophaea woolhopeia** with somewhat larger and broader spores. The synonymy has been confused, since apparently both Winter (**1881**) and Keissler (**1917**) thought Sauter had never published the name and that it was a nomen nudum until Winter described it. They both apparently missed the description in Flora in 1845, though Keissler actually cited the treatment by Poetsch und Schiedermayr where the name **Humaria albobadia** appeared 9 years before Winter's redescription.

2. [TRICHARIA ALBOFLAVA (Saut.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.]

This is based on Saccardo's (**1889**) misspelling of **Peziza albobadia** Saut., carelessly adopted by Kuntze, Rehm, and Boudier without checking the original publication (see Doubtful Species #1, above).

3. TRICHARIA ARTICULATA (Karst.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
= **Peziza articulata** Karst., Syn. Peziz. Ascob. fenn. p. 13. 1869.
= **Lachnea articulata** (Karst.) Sacc., Syll. Fung. **8**: 184. 1889.
= **Scutellinia articulata** (Karst.) O. Kuntze, Rev. Gen. Pl. **2**: 869. 1891.

This is on the wrong substrate, a moss (**Polytrichum commune**), for this to be a species of **Tricharina** or of **Wilcoxina**.

4. TRICHARIA HYSTRIX (Saut.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
= **Peziza hystrix** Saut., Flora **24**: 311. 1841.
= **Lachnea hystrix** (Saut.) Sacc., Syll. Fung. **8**: 187. 1889.
= **Scutellinia hystrix** (Saut.) O. Kuntze, Rev. Gen. Pl. **2**: 869. 1891.

Keissler (**1917**) synonymized this with **Scutellinia setosa** (Nees : Fr.) O. Kuntze. The woody substrate is wrong for **Tricharina** or for **Wilcoxina**.

5. TRICHARIA LIVIDA (Schum. : Fr.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
= **Peziza livida** Schum. : Fr., Enum. Pl. Saell. 2: 422. 1803.
= **Trichophaea livida** (Schum. Fr.) Boud., Icon. Mycol., Liste prélim. p. [3]. 1904.

The epithet has seen disparate use, and the above is only a partial synonymy. The spores of the fungus in the sense of Boudier are too strongly marked for a **Tricharina**, and the habit on wood is also wrong for that genus.

6. TRICHARIA MARTII (Strauss in Sturm) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
   - = **Peziza martii** Strauss in Sturm, Pilze Deutschl., Heft. 33: 19. pl.10. 1853.
   - = **Lachnea martii** (Strauss in Sturm) Sacc., Syll. Fung. **8**: 167. 1889.
   - = **Scutellinia martii** (Strauss in Sturm) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.

Strauss's type is unknown. The apothecia, 1.5-2.0 cm diam, seem much too large for a **Tricharina**. The illustration of the asci and spores is nearly useless for diagnosis, and the huge basal swelling of the hairs is unlike any species known to us.

7. TRICHARIA OBTUSIPILA (Pat.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
   - = **Humaria obtusipila** Pat., Cat. pl. cell. Tunisie p. 94. 1897.

Though this species could well be a **Tricharina**, the type specimen was not located either at FH-Patouillard or at PC (Pfister, **1977**, **1980**).

8. TRICHARIA SCHISTARENARIA (Saut.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
   - = **Peziza schistarenaria** Saut., Hedwigia **16**: 73. 1877.
   - = **Lachnea schistarenaria** (Saut.) Sacc., Syll. Fung. **8**: 186. 1889.
   - = **Scutellinia schistarenaria** (Saut.) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.

Though said by Saccardo (**1889**) to be near '**Lachnea**' **livida** and by Rehm (**1895**) to be near **Trichophaea gregaria**, the type specimen was not found either by Winter (**1881**) or by Keissler (**1917**), and the species appears to be lost. In Keissler's words: "Da somit eine Untersuchung der Fruchtschichte zur Ergänzung der von der Art nur auf Grund der makroskopischen Merkmale gegebenen Beschreibung nicht möglich ist, muss **P. schistarenaria** Saut. als **Art einfach gestrichen werden.**"

9. TRICHARIA SPHAGNI (Bong. in Weinm.) Boud. (as 'Sphagnii'), Hist. Classific. Discomyc. Europe p. 58. 1907.
   - = **Peziza sphagni** Bong. in Weinm., Hymeno- Gastero-myc. p. 428. 1836.
   - = **Humaria sphagni** (Bong. in Weinm.) Sacc., Syll. Fung. **8**: 140. 1889.

The substrate, **Sphagnum obtusifolium**, appears wrong for a species of **Tricharina** or of **Wilcoxina**. The type specimen is unknown to us. The hymenium was said to be dark purple and the obtuse margin somewhat incurved.

10. TRICHARIA WARNSTORFIANA (P. Henn.) Boud., Hist. Classific. Discomyc. Europe p. 58. 1907.
    - = **Lachnea warnstorfiana** P. Henn., Verh. Bot. Vereins Prov. Brandenburg **41**: xi. 1900 (1899).

We have not located the type specimen, presumably destroyed in World War II in the bombing of Berlin, but the tiny hairs, small spores and small asci all point to this being an inoperculate discomycete.

11. TRICHARIA WIMPFENIANA (Bizz.) Boud., Hist. Classific. Discomyc. Europe p. 57. 1907.
    = **Peziza wimpfeniana** Bizz., Atti Ist. Veneto Sci. Lett. Arti, ser. 6, 3: 303. 1885.
    = **Lachnea wimpfeniana** (Bizz.) Sacc., Syll. Fung. 8: 168. 1889.
    = **Scutellinia wimpfeniana** (Bizz.) O. Kuntze, Rev. Gen. Pl. 2: 869. 1891.

The type specimen is unknown to us, but the original description, illustrations, and substrate (rotting grapes) suggest this may be a species of **Cheilymenia**.

HERBARIUM SPECIMENS MISIDENTIFIED AS TRICHARIA OR AS TRICHARINA BUT EXCLUDED FROM BOTH TRICHARINA AND WILCOXINA

HERBARIUM BPI

Humaria ochroleuca, F.E. Clements #10, Minnehaha, Colorado, Aug. 8, 1899. This is **Geopyxis** sp., probably **G. vulcanalis** (Peck) Sacc. as conceived by Seaver (1942).

Patella sequoiae, Fungi of California, Herb. Univ. California, H.E. Parks #4733, on **Alnus rubra** Bong., Calif. This is **Scutellinia** sp. with single, rooting hairs, not **Peziza sequoiae** Phill.

HERBARIUM C

Lachnea lojkeana, ex Herb. E. Rostrup, 11/1895, on rotting seeds. Probably a species of **Byssonectria** (= **Inermisia**), with apothecia in poor shape, ascospores guttulate and not yellow-refractive.

Tricharina cretea, Sjaelland, on calcareous soil mixed with **Marcellina persoonii** and **Ascobolus viridis**, leg. H. Dissing #65.83, 13.8.1965. This is **Cheilymenia** sp., ascospores smooth and eguttulate, hairs single.

Tricharina sp., Greenland, on old dung of musk ox, leg. H. Dissing #GR83.105, Aug. 6, 1983. No **Tricharina** found, but there are at least four discomycetes in the collection: **Lasiobolus cuniculi** Vel., **Thecotheus cinereus**, **Coprotus** sp. (new? 4-spored), and **Cheilymenia** sp.

Tricharina sp., Greenland, on old dung of musk ox, leg. H.Dissing #GR83.60, July 30, 1983. No **Tricharina** found, but four discomycetes are present on the dung: **Lasiobolus cuniculi**, **Thecotheus cinereus** (spores only seen), **Coprotus** sp. (new? 4-spored), and **Cheilymenia** sp.

HERBARIUM CUP

Lachnea cretea, Durand #202 ex Herb. Crossland, Halifax, leg. J. Needham, 4.11.1898 (= Korf 864). This is **Trichophaea hemisphaerioides** with biguttulate, roughened ascospores.

Tricharina bisetosa (isotype), ex Herb. J. Moravec (=PAN 2408), CUP 61633, on wood, leg. S. Chander, 17.8.1971. This is transferred here to **Cheilymenia** as **C. bisetosa** (see Excluded Species # 1.)

HERBARIUM G

Tricharina subglobispora (holotype), GR 12509, Austria, Sonntagberg, ad terram nudam deustam, viii.1908, leg. P. Strasser. Includes at least two discomycetes, **Trichophaea woolhopeia** and **Sphaerosporella brunnea**. See Excluded Species #5, above.

HERBARIUM H

Peziza luteopallens (holotype), redet. **P. merdaria** Fr. by Karsten, Fennia. Nylandia. Helsinki, ad observatorium astronomicum, leg. W. Nylander, 21.x.1862. This is a species of **Pseudombrophila**, with smooth ascospores, yellow-refractive in lactic acid, with deBary bubble and cyanophilic sheath, apothecial margin dentate, with some short hair-like processes glued in a tomentum.

Tricharina gilva ?, EH. Lammi, Pappilankyla, Biological Station, fertile bare ± mull, leg. R. Gronroos, 3.ix.1979. This is **Byssonectria** sp., with ascospores biguttulate, tapering and thickened ends, apothecial margin dentate, attached with "tomentum" to substrate.

Tricharina gilva, N. Bromarv:Sando, gransar till Bkorkskar, hjulspar, leg. E. Hayren, 7.viii.1938. This is **Trichophaea gregaria f. gregaria** (see Korf and Gruff, 1981).

Tricharina ?, leg. L. Fagenstnoin, 10.viii.1972. This is also **Trichophaea gregaria f. gregaria.**

HERBARIUM K

Humaria hirtella f. minor (isosyntype of **Lachnea amphidoxa** Rehm), Rehm Ascomyceten #605, leg. G. Winter, 4/1881. This is a **Cheilymenia** sp. with coarsely ornamented, eguttulate ascospores and forked, rooting hairs.

Humaria hirtella f. minor (isosyntype of **Lachnea amphidoxa**), leg. P. Sydow, 7.1885. This is a species of **Cheilymenia** with finely ornamented, eguttulate ascospores and forked, rooting hairs. Le Gal (1953: 169, footnote) also placed the Rehm portion of this collection in **Cheilymenia**, but noted an interperisporic layer, with anastomosing pustules, that detached easily from the ascospores. This and the preceeding appear to represent different species of **Cheilymenia**, and we leave designation of a lectotype to a future monographer of that genus. The spores of this collection are smaller than those of the preceeding one.

Lachnea eichleri, ex Herb. Carleton Rea-Pres. 1946. This is **Trichophaea hemisphaerioides** (Mouton) Graddon with biguttulate ascospores with cyanophilic warts.

Lachnea livida, Otto Jaap, Fungi selecti exs. #455. This is a **Scutellinia** with single, rooting hairs and bi- to multiguttulate ascospores.

Lachnea sequoiae, Harkness 636 (syntype). The ascospores are smooth, eguttulate, with an outermost cyanophilic sheath; the hairs are single, slightly rooting, and with bulbous basal cells, and we place this tentatively in **Cheilymenia**. There are similarities between this species and **Cheilymenia bisetosa** (see Excluded Species #1, above) such as slightly rooting hairs, similar spores, and lignicolous habitat. Another syntype is on deposit as **Peziza sequoiae** (see below).

Peziza livida, Broome, 1886. This is **Scutellinia** sp., hairs single and rooting, ascospores biguttulate or with many internal guttules.

Peziza livida, ex Herb. Sowerby, 2-1859. This proves to be an inoperculate discomycete, possibly a **Mollisia.**

Peziza olivascens (isotype), Erb. Crittog. Ital. #585. This is a **Scutellinia**, possibly **S. umbrarum.** See Excluded Species #4 above.

Peziza sequoiae, Harkness 638 (syntype). See **Lachnea sequoiae** above.

Tricharia fimbriata, Needham #36. This is **Cheilymenia** sp., with single hairs and smooth, eguttulate ascospores.

Tricharia ochroleuca, leg. H.M. Putterill, near Alice, Cap Province, S. Africa, 1938. This is not a **Tricharina**, but the apothecia are in bad shape, beyond regognition; the ascospores are smooth and biguttulate.

HERBARIUM NY

Tricharina gilva, on flat of sand in greenhouse, Duke University, leg. F.A. Wolf, 15. Nov. 1968. This is a **Trichophaea** with smooth, biguttulate ascospores.

HERBARIUM O

Tricharia cretea, Nesset, Norway, leg. A.-E. Torkelsen #710/74, 2.8. 1974. This is **Trichophaea gregaria** f. **gregaria.**

Tricharina, Eidsvoll, Norway, leg. B. Grenger, 11.10.1970. This is **Scutellinia** (**scutellata** ?) with single, rooting hairs and guttulate ascospores.

HERBARIUM PAN

Tricharina bisetosa [PAN 2408 (holotype) and 2434 (paratype)]. Both are here referred to **Cheilymenia** as a new combination, **C. bisetosa** (see Excluded Species # 1, above). The hairs are slightly rooting, not fasciculate, and the spores smooth and eguttulate.

HERBARIUM PC

Tricharia gilva, ex Herb. Grelet, Nov. 1924, on soil with mosses. This is **Trichophaea gregaria** f. **gregaria**, with ornamented, biguttulate ascospores.

Tricharia praecox, leg. Ludwig, 15 July 1907. This is **Trichophaea gregaria** f. **laevispora** Korf & Gruff (see Korf and Gruff, 1981), with smooth, biguttulate ascospores.

HERBARIUM PRM

Lachnea gilva, PRM 129079, J. Klinka, in carbonario in monte Jaly, montes Krknośe, Bohemia, viii.1923. This is **Anthracobia** sp. with smooth, biguttulate ascospores and rudimentary, marginal hairs.

Lachnea gilva, PRM 823504, L. Kubičková & M. Svrček, inter muscos ad terram, silva konifer, Bohemia merid: Jindřichuv Hradec., 2.vi.1963. This is **Trichophaea hemisphaerioides** with biguttulate ascospores and apothecia up to 5 mm diam when dried.

HERBARIUM S

Lachnea gilva, ex Herb. Bresadola, no date. This is **Anthracobia** sp. with smooth, guttulate ascospores and rudimentary hairs.

Lachnea gilva, ex Herb. Bresadola, leg. Rick. This is a **Cheilymenia** with smooth, eguttulate ascospores and single, rooting hairs.

Lachnea gilva, ex Herb. Rehm, 9-1897. A species of **Cheilymenia** with smooth, eguttulate ascospores and single, rooting hairs.

Lachnea luteopallens, ex Herb. Rehm, 26.vi.1891, leg. Wagner. A species of **Cheilymenia** with smooth, eguttulate ascospores and single, rooting hairs.

Lachnea luteopallens, ex Herb. Rehm, 1910. This is a **Cheilymenia** with ornamented, eguttulate ascospores and rooting hairs.

Lachnea ochroleuca, ex Herb. Bresadola, 1906. A species of **Scutellinia** with guttulate, warted ascospores and single, rooting hairs.

HERBARIUM TRH

Tricharina sp., S. Sivertsen #83-115. This is **Cheilymenia** sp., with smooth, eguttulate ascospores and single hairs.

Tricharina sp., S. Sivertsen #83-116. **Cheilymenia** sp., with single hairs and smooth, eguttulate ascospores.

HERBARIUM UPS

Humaria hirtella f. minor, Sydow Mycoth. march. #776 (isosyntype of **Lachnea amphidoxa**). See above, Herbarium K.

HERBARIUM OF R. P. KORF

Tricharina cretea, Korf #3000, on leaves over fireplace, Ringwood, Tompkins County, NY, leg. Mary Elliott #67-1 et al., 24.iv. 1961. This is a **Fimaria** with smooth, strongly cyanophilic, yellow-refractive ascospores forming deBary bubbles.

Tricharina? Cheilymenia?, on soil, Oze, Nikko Pref., Honshu, Japan, leg. Y. Kobayasi, 2.x.1950 (Korf #JA-1747). This is neither a **Tricharina** nor a **Cheilymenia**; the ascospores have a large guttule and no yellow-refractive coloration. Possibly this is a **Trichophaea**, but the specimen had been fixed in formalin which could ruin apothecial structures for critical examination.

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INDEX TO FUNGOUS AND LICHEN TAXA, VOLUME TWENTY-FOUR

This index includes genera, infrageneric taxa, species, and infraspecific taxa. New taxa are underlined, as are the pages on which they are published. There is one new family, MYXOTRICHACEAE. The monograph on Onygenales by Currah (pp. 1-216) is separately indexed, and for some of the larger genera the indication "see 210-216" is used to refer to that index.

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ERRATUM, VOLUME TEN

Page 471, line 12:	for 1258: Tenerife. read 1256: Tenerife.

ERRATUM, VOLUME THIRTEEN

Page 140, line 3 of first caption:	for CUP-MM 1145, read CUP-MM 1281,

ERRATA, VOLUME TWENTY-TWO

Page 441, line 6:	for predominatly read predominantly
10:	for words, read woods,
23–24:	for [x0.7], 8-12-81-F [x0.6], 8-15-82-B [x0.7] read [x0.53], 8-12-81-F [x0.41], 8-15-82-B [x0.53])

ERRATA, VOLUME TWENTY-THREE

Page 483, line 12:	for speciesand read species and
Page 484, line 20:	for Telsa read Tesla
Page 485, line 37:	for seesm read seems
Page 493, line 17:	for 1984 read 1964
Page 494, line 16:	for "Karlova read "Králova
Page 495, line 18:	for up to 20 read up to 22
Spine:	for 1–516 + i–iv. read 1–516 + i–iv, INDICES.

ERRATA, VOLUME TWENTY-FOUR

Page 260, line 44:	for Pe. read Pu.
Page 261, line 28:	for P. read Pu.
36:	for P. read Pu.
Page 298, line 43:	for A. read Acrocordia
Page 412, line 34:	for proliferiodes read proliferoides
45:	for monosporous read monosporus
51:	for Fitzpatric read Fitzpatrick
54:	for cinnamoni read cinnamomi
Page 413, line 5:	for spetisporangium read septisporangia
Page 414, line 7:	for clorata read chlorata
14:	for septisporangium read septisporangia
Page 415, line 5:	for clo hlorata
12:	for septisporangium read septisporangia

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